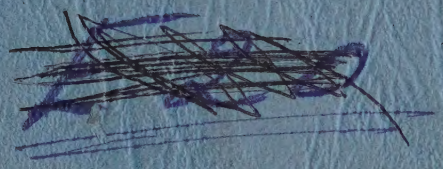
FREQUENCY AND TIME MEASURING INSTRUMENT TYPE TSA 3436/2



Instruction Manual

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VENNER ELECTRONICS LIMITED
Kingston By-Pass New Malden Surrey MALden 2442

A member of the Venner Group of Companies

FREQUENCY AND TIME MEASURING INSTRUMENT TYPE TSA 3436/2

Instruction Manual

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VENNER ELECTRONICS LIMITED

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Illustrations

Layout of TSA3436/2 (page 9)	Figure 1
Frequency and Time Measuring Equipment TSA3436/2 (circuit dgm.)	ES66/16
Double MF Decade Unit Type TPC60	E32/77
Double MF Decade Unit Type TPC60/1	E32/84
HF/MF Decade Unit (divider) Type TPC61	E32/78
HF/MF Decade Unit (counter) Type TPC61/1	E32/98
Crystal Oscillator Unit Type TPC62/1	E32/99
Pulse Shaper & Gate Unit Type TPC67	E66/15
Blanking Circuit Unit Type TPC34	E66/9
Power Supply Unit Type TPC20	E66/17
B.C.D. Buffer Type TPC17	E66/18

1. INTRODUCTION

The 'TSA three-four-three-six-mark-two' is a compact portable instrument designed to measure the frequency of signals up to 1·2Mc/s and the period of signals up to 100kc/s: the unit may also be operated as a counter or timer. Measurements are displayed by six in-line in-plane digital indicators; and binary coded decimal output facility may be fitted as an optional extra.

For each of the functions Frequency and Period, switched ranges are provided. On Period function, measurements can be recorded over a duration equal to 1, 10 or 100 cycles of the input waveform.

The instrument may be set for successive measurements to be made automatically, each readout being displayed for a period adjustable between approximately 1 and 5 seconds; alternatively, a measurement may be made and the display retained until a reset push-button is operated. A Blanking switch determines whether the indicator numerals are displayed during the process of measurement.

Any one of eight standard frequency outputs may be selected, and the gating and reset circuits can be controlled by external signals.

Self-testing facilities are incorporated in the TSA3436/2, which employs transistorized printed circuit stages. An oven-controlled crystal oscillator serves as internal reference source: provision is also made for the use of an external reference source.

The instrument is contained in a light grey P.V.C.-covered dual-sectioned case. The front and rear panels are recessed and finished in light French blue. The carrying-handle is designed for use as a stand and thus enables the unit to be inclined for convenience of operation and viewing.

2. SPECIFICATION

2.1 POWER SUPPLY

Mains:	100-125V, 40-60c/s or 200-250V, 40-60c/s (Mains adjustment by tap on transformer: see Section 4.1) Consumption approx. 32W
Battery:	12V d.c. Consumption approx. 22W

2.2 MAXIMUM D.C. COMPONENT OF INPUT SIGNAL

400V (Permissible on A.C. Input setting only)

2.3 FREQUENCY FUNCTION

Ranges:	A.C: 15c/s to 1·2Mc/s D.C: D.C. to 1·2Mc/s
Accuracy:	±1 count ± crystal stability Crystal frequency: 1Mc/s Crystal stability: ± 1 part in 10^6 for any constant ambient temperature in range 0° to +40°C. ± 2 parts in 10^6 for variation of ambient temperature in range 0° to +40°C.
Signal Specification:	A.C: Min. amplitude 100mV r.m.s. Max. amplitude 250V r.m.s. D.C: Max. amplitude ±50V peak Trigger level -2V max.
Input Impedance:	A.C: 100kΩ shunted by 60pF D.C: 10kΩ shunted by 120pF
Gating Times (selectable):	0·1, 1, 10 seconds
Count Capacity:	999999

2.4 PERIOD FUNCTION

Ranges:	A.C: 15c/s to 100kc/s D.C: D.C. to 100kc/s
Accuracy:	As stated in Section 2.3
Signal Specification:	As stated in Section 2.3
Input Impedance:	As stated in Section 2.3
Gating Times (selectable)	1, 10, 100 cycles of input frequency
Time Units:	1μs to 100ms in decade steps
Count Capacity:	999999

2.5 COUNT FUNCTION

Count Capacity:	999999
Ranges:	A.C: 15c/s to 1·2Mc/s D.C: D.C. to 1·2Mc/s
Signal Specification:	As stated in Section 2.3
Input Impedance:	As stated in Section 2.3

For control signals (start & stop) see Section 2.7

2.6 TIMING FUNCTION

Range:	1μs to 100000 seconds (approx. 1·1 days)
Accuracy:	As stated in Section 2.3
Time Units:	1μs to 100ms in decade steps

For control signals (start & stop) see Section 2.7

2.7 START & STOP INPUTS (external gating)

Signal Amplitude:	5V to 10V positive pulse
Max. Rise Time:	0·2μs
Min. Pulse Width:	0·5μs
Input Impedance: (each line)	approx. 5kΩ in series with 200pF

2.8 RESET SIGNALS

Input:	Signal amplitude:	5V positive pulse
	Max. rise time:	approx. 20μs
	Min. pulse width:	approx. 100μs
	Input impedance:	approx. 2kΩ
Output:	Signal amplitude:	4V negative pulse
	Pulse rise time:	approx. 10μs
	Pulse width:	approx. 200μs
	Output impedance:	approx. 500Ω

2.9 EXTERNAL (Crystal) REFERENCE INPUT

Signal amplitude:	1V to 3V r.m.s.
Frequency:	1Mc/s for standard functions. For non-standard functions, frequency range: 200kc/s to 1·2Mc/s (Refer to Section 4.10)
Input Impedance:	1MΩ shunted by 120pF

2.10 BINARY CODED DECIMAL OUTPUT (1-2-4-2' code)

	Output Impedance (approx.)	Min. Load Resistance*	Open Circuit d.c. levels* (approx.)
Digit Lines:			
Least-significant-digit:	6kΩ	25kΩ	Mark : -8V No mark : -2·8V
Other digits :	2kΩ	25kΩ	Mark : -7·3V No mark : -2V
Print Command :	2kΩ	2kΩ	Print : -7·3V Stand-by : -2·2V
Reset In :	Refer to 'Input' in Section 2.8		

*With respect to chassis-earth

2.11 STANDARD FREQUENCY OUTPUT

Output Frequency: Dependent upon setting of Function Selector switch, viz:

Switch Setting		Std. Frequency	Mark/Space Ratio (approx.)
Frequency	X0·1	0·1c/s	1 : 4 (-ve pulse)
	X1	1c/s	1 : 4 (-ve pulse)
	X10	10c/s	1 : 4 (-ve pulse)
Period	100ms	10c/s	1 : 4 (-ve pulse)
	10ms	100c/s	1 : 4 (-ve pulse)
	1ms	1kc/s	1 : 4 (-ve pulse)
	100μs	10kc/s	1 : 4 (-ve pulse)
	10μs	100kc/s	See note below
	1μs	1Mc/s	1 : 1

(Note: 100kc/s: positive-going pulses approx. width 2μs)

Signal amplitude: approx. 5V

Output impedance: approx. 2kΩ

2.12 DISPLAY TIME

'Auto' setting: adjustable between approx. 1 and 5 seconds

'Manual' setting: display retained until reset push-button is pressed

2.13 TEMPERATURE RANGE

0° to +40° Centigrade

2.14 DIMENSIONS & WEIGHT

Width	Height	Depth (front to rear)	Weight
14¼ in	3⅞ in	10½ in	13lb
(36cm)	(10cm)	(27cm)	(5·9kg)

3. ARRANGEMENT OF OPERATING CONTROLS

3.1 FRONT PANEL

To the right of the display screen is the 10-position Function Selector. The extreme anti-clockwise setting of this switch serves as an 'OFF' position when the instrument is fed by mains.* The next three positions marked, X0·1c/s, X1c/s and X10c/s respectively, are for use on Frequency function; the remaining six positions, marked 100ms, 10ms, 1ms, 100μs, 10μs and 1μs respectively, are for use on Period function.

---

*Note: For battery switching refer to Section 4.2.2

On the right of the panel are mounted an 'A.C./Test/D.C.' selector switch, an 'A.C. Sensitivity' control and two signal input terminal sockets.

The following controls are mounted below the indicators:

Reset Zero switch (marked: Manual/Auto) with Reset Zero push-button

Display Time Control

Blanking switch

Period Cycles selector (positions: 1, 10, 100)

Reset Nine push-button

3.2 REAR PANEL

On the left of this panel (unit viewed from rear) are mounted the following:

Gate Control switch (marked: Internal/External) with associated Start and Stop input sockets for use when the switch is set to External

Chassis-earth socket

Reset Input and Output sockets

Standard Frequency output socket

Crystal Reference switch (marked: Internal/External) with associated external reference input socket for use when the switch is set to External

Fuse 0·5A (H.T. supply)

Mains/12V D.C. supply selector switch

12V D.C. input socket

An entry for the mains cable is provided in the left lower corner.

On the right of the panel Set Zero and Set Nine controls of the indicators are mounted in two rows.

Two cable-wrapping knobs and a cable clip are fitted on the panel to facilitate stowage of the mains cable when it is not in use.

4. OPERATING INSTRUCTIONS

4.1 MAINS-VOLTAGE SETTING

Check that the tapping selected on the internal mains transformer is suitable for the supply voltage. Access to the transformer may be gained by removal of the lid of the instrument, which is held in position by two screws, one at each side of the unit.

The wire connected to the 0V tag of the transformer should not be removed, as this is the neutral supply line. The remaining wire, the live line, is provided as the movable lead; this should be soldered to the tap most appropriate for the supply voltage.

In Figure 1 the tags are coded by the letters t - z; the following list associates them with their corresponding voltages.

Transformer (T1) References

t = 0V (neutral supply line)
u = 102V tap
v = 112V tap
w = 122V tap
x = 205V tap
y = 225V tap
z = 245V tap

Replace and secure the lid before connecting the mains supply.

4.2 CONNECTION OF SUPPLY

4.2.1 Mains

Having checked the voltage setting of the mains transformer (Section 4.1) proceed as follows.

(i) Set Function Selector to 'OFF'
(ii) Set Mains/12V D.C. switch to 'Mains'
(iii) Connect supply to the 3-core mains cable as below.

Red core	:	Mains live
Black core	:	Mains neutral
Green core	:	Earth

Clockwise rotation of the Function Selector to any one of the Frequency or Period positions switches ON the supply within the unit for instrument operation.

4.2.2 Battery

(i) Set Mains/12V D.C. switch first to 'Mains'
(ii) Connect the 12V D.C. battery-supply to 3-pin rear-mounted socket as follows.

Viewed from rear of unit:

1st pin in anti-clockwise direction from locating inset : POSITIVE

1st pin in clockwise direction from locating inset : NEGATIVE

For battery operation the Mains/12V D.C. switch may be used as an ON/OFF control, the battery-supply being fed to the internal circuit when the switch is set to the 12V D.C. position. Although current is then drawn from the supply the Function Selector must be set to one of the Frequency or Period positions for instrument operation.

4.3 CHECKING INDICATOR DISPLAYS

It is recommended that an initial check, and subsequent occasional checks, be made on the indicator displays.

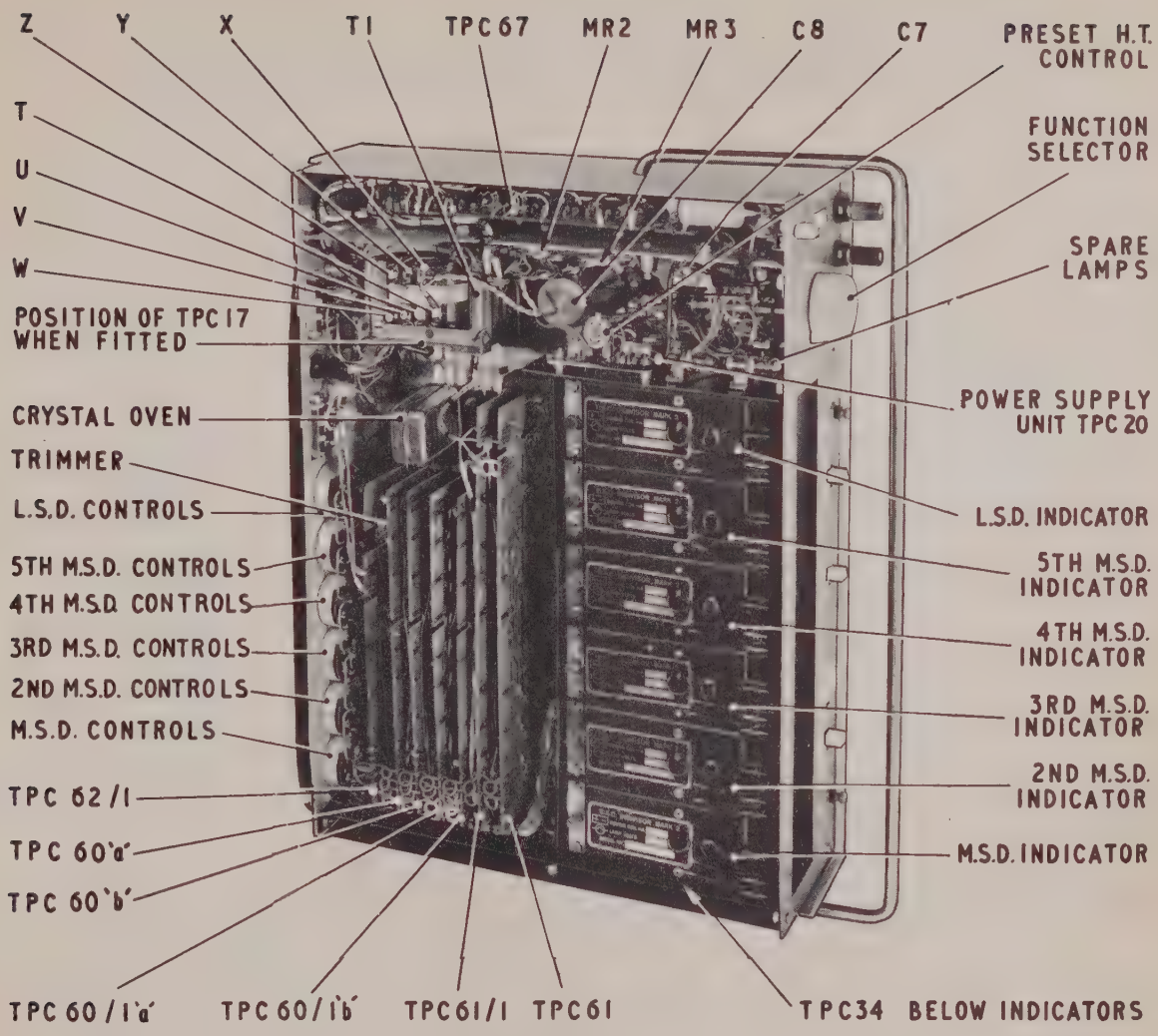

Figure 1 Layout of TSA3436/2

Circuit references relative to diagram ES66/16

To check the displays, the following switch settings should be established.

	Switch		Setting
Front:	Reset Zero	:	Manual
	Blanking	:	OFF
	Function Selector	:	Any Frequency position
	A.C./Test/D.C.	:	D.C.

For each indicator a Set Zero and a Set Nine control are provided so that, when the display presentations are being checked, the figures 0 and 9 may in turn be set symmetrically about the vertical axes of the indicator frames. The 'Set Zero' potentiometers (RV1, 3, 5, 7, 9 & 11)* form a row of controls near the upper edge of the rear panel: in-line below these are the 'Set Nine' potentiometers (RV2, 4, 6, 8, 10 & 12).* Refer to Figure 1 for indicator-to-control relationship.

With no signals applied at the input terminals proceed as follows.

(i) Momentarily depress the Reset Zero push-button to obtain the display: 000000 Check each '0' for symmetry: adjust Set Zero controls where necessary.

(ii) Momentarily depress the Reset Nine push-button to obtain the display: 999999 Check each '9' for symmetry: adjust Set Nine controls where necessary.

(iii) Repeat procedures (i) and (ii) until symmetrical 0 and 9 displays are obtained without adjustments.

4.4 TEST FACILITY

In order that the counting and readout operations of the instrument may be periodically checked, provision is made for feeding 100c/s output signals of the frequency divider chain to the signal input circuit.

Note: The Test function may be used while signals are present at the input terminals providing their amplitude does not exceed 10V peak: otherwise signal breakthrough may interfere with the test operations and give rise to incorrect counts.

To use this facility first set the switches as indicated below.

	Switch		Setting
Rear:	Gate Control	:	INT
	Crystal Reference	:	INT
Front:	Reset Zero	:	As required
	Blanking	:	OFF
	A.C./Test/D.C.	:	Test

*Circuit diagram ES66/16 references

The following list shows the respective displays which should be obtained for the various settings of the Function Selector and Period Cycles switch.

Function Selector Setting		Display (Period Cycles switch: any position)
Frequency X0·1c/s	:	001000±1
Frequency X1c/s	:	000100±1
Frequency X10c/s	:	000010±1

			Display		
		Period Cycles:	X1	X10	X100
Period	100ms	:	000000±1	000001±1	000010±1
Period	10ms	:	000001±1	000010±1	000100±1
Period	1ms	:	000010±1	000100±1	001000±1
Period	100μs	:	000100±1	001000±1	010000±1
Period	10μs	:	001000±1	010000±1	100000±1
Period	1μs	:	010000±1	100000±1	000000±1

4.5 FREQUENCY FUNCTION

4.5.1 Principle of Operation

In this function the input signals are gated for a definite period determined by the setting of the Function Selector. The cycles of input frequency so gated are counted by a chain of six decades. The six indicators display the resultant count.

4.5.2 Measurement Procedure

(i) Set rear-mounted Gate Control and Crystal Reference switches to INT.

(ii) Select Manual or Auto reset-zero by use of Reset Zero switch. If Auto reset is selected, set Display Time control as required. (Display time for min. setting approx. 1 second, for max. setting approx. 5 seconds.)

(iii) Set Blanking switch to ON if no display is to be shown until the end of each measurement.

(iv) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer to Section 4.11.

(v) Select A.C. or D.C. input coupling by use of A.C./Test/D.C. switch. If A.C. is selected turn A.C. Sensitivity control to MAX.

Note: This sensitivity setting is suitable for smooth-edged waveforms of amplitude 100mV to 250V r.m.s. When interference is present or the rising and/or falling waveform-edges are irregular (due to harmonic content) the sensitivity should be appropriately reduced if it is found, during a few initial measurements, that the instrument is triggered more than once in a cycle: the latter is manifested by abnormal counts.

(vi) Connect the input signal leads to the terminals (Red: 'high' signal line. Black: 'earth' line).

(vii) Set Function Selector to suitable range for measurement of input frequency. When order of frequency is unknown, use highest range (X10c/s) first.

(viii) If Manual reset has been selected, momentarily depress Reset Zero push-button to initiate a measurement. When Auto reset is selected, measurements are initiated automatically.

The gating times for the ranges are as follows:

10 seconds on Frequency X0·1

1 second on Frequency X1

0·1 second on Frequency X10

As each display is the count of input cycles received during the gating time, each read-out should be multiplied by the appropriate range factor (0·1, 1 or 10). The result is a frequency measurement in cycles per second.

Note: It should be noted that it is possible to exceed the count capacity of the instrument during a measurement: this is dependent upon the input frequency and the range employed. The most significant digit indicator resets from 9 to 0 each time that the count capacity is exceeded.

Example:

A frequency of 1,000,002·3c/s applied on the range Frequency X10 would produce the measurement 100,000* X10c/s (i.e., 1Mc/s). The same frequency applied on the range Frequency X1 would cause the count capacity of the instrument to be exceeded once during the measurement and give rise to the display 000002*. The most significant digit (M.S.D.) would not be shown but the extreme right hand indicator would display the 7th M.S.D.

Similarly, on the range Frequency X0·1 the count capacity of the instrument would be exceeded ten times during the measurement and a resultant display of 000023* would be shown.

4.6 PERIOD FUNCTION

4.6.1 Principle of Operation

In this function, the input signals control the internal gate which is held open for a time equal to 1, 10 or 100 periods of the input frequency (depending upon the setting of the Period Cycles switch). While the gate is open, pulses derived from the crystal oscillator (and of repetition rate determined by the setting of the Function Selector) pass via the gate to a six-decade counter chain. The resultant count, which is displayed by the indicators, is therefore a measurement of the time for which the gate is held open and is thus a Period measurement of the input waveform.

4.6.2 Measurement Procedure

Carry out procedures (i) to (vi), inclusive, of Section 4.5.2; then proceed as follows:

(a) Set Period Cycles switch to 1 (i.e., so measurement will be taken initially over 1 period of input waveform).

(b) Set Function Selector to suitable range. When order of signal period is unknown, use highest range (100ms) first.

---

*Subject to the accuracy quoted in Section 2.3

(c) If Manual reset has been selected, momentarily depress Reset Zero push-button to initiate a measurement. When Auto reset is selected, measurements are initiated automatically.

The count, registered while the gate is held open, is recorded in units of time indicated by the setting of the Function Selector*. The final display multiplied by the range factor gives the Period measurement in milliseconds or microseconds, depending upon the range selected.

Note: In this function, as in the case of Frequency function, the count capacity of the instrument may be exceeded in recording a measurement.

With Period Cycles switch settings of 10 and 100 the resultant time displays are respectively ten times and one hundred times greater than the actual period of the input waveform. These switch settings are particularly useful for period measurement of high frequency signals.

Example:

A frequency in the order of 95kc/s, having a period of 10·52μs, applied on the 'Period 1μs' range would give rise to the display 000010**(μs) if measured over 1 cycle. However, the 3rd and 4th most significant digits (52) would be displayed if the measurement were taken over 100 cycles: the display would be 001052**(μs), thus indicating a signal period of 10·52μs.

4.7 COUNT & TIMING FUNCTIONS

The rear-mounted START and STOP input sockets, associated by engraving with the Gate Control switch, are used for functions Count and Timing.

With the switch set to 'INT', gating action is controlled internally, and both input sockets are isolated from the functional circuit.

With the switch set to 'EXT' the gate is controlled externally; the gate is opened when a suitable signal*** is presented between the START socket and the adjacent earth socket and closed when a second such signal is presented between the STOP socket and the earth socket.

The START and STOP inputs may be linked together if single-line gate control operation is required. In such a case two successive signals presented (after the occurrence of reset action) between the link and the earth socket cause the gate to open and close respectively.

---

*The Function Selector indications are also the respective repetition rates at which pulses are fed to the counter while the gate is held open.

**Subject to accuracy quoted in Section 2.3

***For signal specification refer to Section 2.7

COUNT:

(i) Set Crystal Reference switch to INT.

(ii) Set Function Selector to any Frequency position and Blanking switch to OFF.

(iii) Select 'Manual' reset-zero; momentarily press Reset Zero push-button.

(iv) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer to Section 4.11.

(v) Select A.C. or D.C. input coupling by use of A.C./Test/D.C. switch. If A.C. is selected turn A.C. Sensitivity control to MAX. and refer to 'Note' in Section 4.5.2.

(vi) Connect the input signal leads to the terminals (Red: 'high' signal line. Black: 'earth' line).

(vii) Set Gate Control switch to EXT and connect the gate control leads to the adjacent START, STOP and earth sockets.

(viii) Momentarily depress Reset Zero push-button: the first external gate-control-signal* applied (after the occurrence of reset action) will cause the gate to open. Random input pulses (or cycles of an input frequency) applied to the input terminals will then be registered by the instrument, the number being displayed by the indicators (Note: count capacity 999999). A second external gate-control-signal (stop-signal) should be applied if the count is required over a definite interval; in this case the Blanking and Auto reset facilities may be used if required; refer to Section 4.5.2., procedures (ii) and (iii).

Count function may be utilized for the measurement of frequency ratio; the lower of the two frequencies concerned (f_L) being applied to the START and STOP inputs (connected for single-line gate control operation), the higher frequency (f_H) being applied to the input terminals on the front panel.

In such a case the gate is opened for a time corresponding to one cycle of f_L; the number of cycles of f_H occurring in this time is displayed by the indicators. The frequency ratio $f_L : f_H$ is:

1 : Displayed Count

(Count accuracy: +0, -1)

Owing to the -1 digit count tolerance, the most accurate results will be obtained when f_H is in the order of 100 x f_L or greater: in certain cases better accuracy may be obtained by using the external reference facility for frequency ratio measurement: refer to Section 4.10.

TIMING OR PERIOD:

(i) Set Crystal Reference switch to INT.

(ii) Select Manual or Auto reset-zero and Blanking as required; refer to Section 4.5.2 procedures (ii) and (iii).

(iii) If B.C.D. output facility (on units having modification 'Z') is to be utilized, refer to Section 4.11.

(iv) Set A.C./Test/D.C. switch to D.C.

(v) Set Gate Control switch to EXT and connect the gate control leads to the adjacent START, STOP and earth sockets (Note: No connections should be made at front panel mounted input terminals).

(vi) Set Function Selector to Period: the range most suitable for the order of the estimated time interval should be used. The switch markings indicate the respective time units in which the interval may be recorded.

(vii) Momentarily depress Reset Zero push-button; then apply 'start' and 'stop' signals*.

*For signal specification refer to Section 2.7

The external gate-control-signals effectively replace the input signals normally applied at the input terminals. Signals derived from the internal oscillator pass to the counter during the interval between the first and second external gate-control-signals. This time is equal to the displayed count multiplied by the range factor and is given in milliseconds (ms) or microseconds(μs) as indicated by the range setting.

Note: If use is made of this function for the measurement of signal period, note that measurements are recorded over one cycle of the input irrespective of the Period Cycles switch setting.

This function may be used for contact timing if contact actuation is arranged to produce suitable gate-control-signals. In certain cases, circuits may be arranged so that, upon contact actuation, the potential of a battery is effective as a gate-control-signal.

4.8 RESET SIGNALS

Reset action within the unit may be initiated externally by applying a suitable signal* between the rear-mounted RESET IN socket and adjacent earth socket. For external triggering the Reset Zero switch should be set to the Manual position to prevent internal reset action occurring automatically.

An output pulse is produced at the RESET OUT socket* whenever reset action occurs within the instrument. This signal may be used to synchronize the resetting of other instruments, or external circuits, with that of the TSA3436/2.

4.9 STANDARD FREQUENCY OUTPUT

The frequency of signals produced at the rear-mounted Std. Frequency socket is dependent upon the setting of the Function Selector as indicated (together with signal details) in Section 2.11. Frequencies ranging, in decade increments, from 0·1c/s to 1Mc/s may be selected.

4.10 EXTERNAL REFERENCE FACILITY

When the rear-mounted Crystal Reference switch is set to INT, the adjacent input socket is isolated from the functional circuit, and the internal 1Mc/s crystal-controlled oscillator is employed as reference source.

When the switch is set to EXT, the internal oscillator is switched out of circuit, and signals applied to the crystal reference socket** serve as reference signals for the instrument.

This facility may be used in cases where it is required to increase the accuracy of the instrument for the standard functions, or where it is required to alter the significance of the readout so that the instrument will operate in a non-standard manner.

Frequency Ratio Measurement

This facility may also be used to measure the frequency ratio of two repetitive waveforms, one of which should be applied to the input terminals, the other to the EXT Crystal Reference socket. The latter waveform should conform to the specification given in Section 2.9: a square waveform may be applied providing the rise time is less than 10μs.

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*For signal specification refer to Section 2.8

**For signal specification refer to Section 2.9

The following control settings should be established.

Crystal Reference switch	:	EXT
Gate Control switch	:	INT
Other controls (excluding Function Selector and Period Cycles switch)	:	As required

Depending upon the order of the frequency ratio, either Frequency function or Period function may be used for the measurement. The two functions will be treated separately.

(a) Frequency Function (Period Cycles switch inoperative)

With the Function Selector set to X10, X1 or X0·1, the frequency applied to the EXT Crystal Reference socket (f_E) passes to the control input of the gate via divider stages having division factors of 10^5, 10^6 and 10^7 respectively. The frequency applied to the terminals (f_T) passes via the gate to the counter chain.

The frequency ratio $f_T : f_E$ is given by

$$1 : \frac{\text{Division Factor}}{\text{Displayed Count}}$$

Example:

With f_E = 500kc/s; f_T = 20kc/s and Function Selector set to 'X1' (i.e. division factor of 10^6):

The gating time = $\frac{10^6}{500000}$ = 2 seconds.

Displayed count = 2 s x 20kc/s = 40000

Hence the ratio is:

$$1 : \frac{10^6}{40000}$$

i.e. 1 : 25

(b) Period Function

With the Period Cycles switch set to X1, X10 or X100 the frequency applied to the input terminals (f_1) passes to the control input of the gate via divider stages having division factors of 1, 10 and 100 respectively.

The Period setting of the Function Selector determines the division factor to which the frequency applied at the EXT Crystal Reference socket (f_2) is subjected before passing via the gate to the counter. The division factors for Function Selector settings (shown in brackets) are as follows.

1(1μs); 10(10μs); 10^2(100μs); 10^3(1ms); 10^4(10ms); 10^5(100ms)

The frequency ratio $f_1 : f_2$ is given by:

$$1 : \frac{\text{Displayed Count x Function Selector Division Factor}}{\text{Period Cycles Division Factor}}$$

Example:

With f_1 = 20kc/s; f_2 = 500kc/s; Function Selector set to '10μs' and Period Cycles switch set to 'X100':

$$\text{The gating time} = \frac{100}{20000} = \frac{1}{200}\,\text{s}$$

$$\text{Displayed count} = \frac{1}{200}\,\text{s} \times \frac{500\text{kc/s}}{10} = 250$$

Hence the frequency ratio is:

$$1 : \frac{250 \times 10}{100}$$

i.e. 1 : 25

Note: Control settings should be chosen such that the capacity of the counter is not exceeded. In general, maximum accuracy is achieved when the displayed count is the highest obtainable without exceeding the counter's capacity.

4.11 BINARY CODED DECIMAL OUTPUT FACILITY

This facility, classified as modification 'Z' and available as an optional extra, is incorporated only if ordered. When the facility is incorporated, the letter Z is included in the type number of the instrument (e.g., TSA3436/2Z).

The B.C.D. outputs are produced (in 1-2-4-2' code) at a 36-pin Amphenol socket mounted on the rear panel above the battery input connector. The connections are as follows.

(Note: M.S.D. = most significant digit)

Pin No.	Output	Pin No.	Output	Pin No.	Output
1	6th M.S.D. 1	13	4th M.S.D. 4	25	Unused
2	6th M.S.D. 2	14	4th M.S.D. 2'	26	M.S.D. 1
3	6th M.S.D. 4	15	Unused	27	M.S.D. 2
4	6th M.S.D. 2'	16	3rd M.S.D. 1	28	M.S.D. 4
5	Unused	17	3rd M.S.D. 2	29	M.S.D. 2'
6	5th M.S.D. 1	18	3rd M.S.D. 4	30	Unused
7	5th M.S.D. 2	19	3rd M.S.D. 2'	31	Reset IN
8	5th M.S.D. 4	20	Unused	32	Unused
9	5th M.S.D. 2'	21	2nd M.S.D. 1	33	Print Command
10	Unused	22	2nd M.S.D. 2	34	Chassis-earth
11	4th M.S.D. 1	23	2nd M.S.D. 4	35	Unused
12	4th M.S.D. 2	24	2nd M.S.D. 2'	36	Unused

Refer to Section 2.10 for signal specification.

Note: To ensure that data logging shall be completed before the instrument is reset, the recording time of the logging equipment must not exceed the minimum display time of the TSA3436/2.

5. MAINTENANCE

Notes: (1) The lid of the instrument may be lifted off after the two securing screws, situated one at each end of the case, have been removed.

(2) When the instrument is used with a mains supply and operation is required with the lid removed, care should be exercised to ensure that no physical contact is made with exposed connections, particularly those of the mains circuit in the region of the transformer and Function Selector.

5.1 INDICATOR LAMP REPLACEMENT

If an indicator lamp fails to function proceed as follows:

(i) Note faulty indicator; switch OFF and disconnect supply; remove lid of instrument.

(ii) Remove two 6B.A. screws securing metal strip at top rear of indicator. The strip with a knurled knob at its centre forms the top of the lamp housing.

(iii) Lift out housing and fit new lamp (E.A.C. Digivisor lamp 12V 2·2W; Venner part No. Z27578). Two spare lamps are provided within the instrument and are mounted in clips beside the Function Selector.

(iv) Replace housing but leave 6B.A. screws loose in position.

(v) Set following controls as indicated.

Control		Setting
Function Selector	:	Frequency (any position)
A.C./Test/D.C. switch	:	D.C.
Reset Zero switch	:	Manual

(vi) Re-connect and switch ON supply: with no signals applied to input terminals, momentarily depress Reset Zero push-button to obtain an all-zeros display.

(vii) Adjust horizontal position of lamp for even illumination of display by sideways movement of entire housing: when appropriate position is found, tighten 6B.A. screws.
Adjust vertical position of lamp by turning knurled knob.

When the adjustments are completed replace and secure the instrument lid.

Note: Some indicators are fitted with a slotted black screw (7/16"D) on the top surface approximately $1\frac{1}{2}$" from the front panel. The setting of this screw should NOT be altered.
The screw is a mechanical zero-centring control which is set, during manufacture, with the lamp illuminated and the deflection coil disconnected.

5.2 H.T. CONTROL

The voltage of the stabilized H.T. supply is determined by a preset potentiometer (RV1 on diagram E66/17) located on the Power Supply Board TPC20: see Figure 1.

In normal circumstances, adjustment of the control should not be required. However, in the event of abnormal instrument operation, or when servicing the equipment, it is advisable to check the H.T. voltage and to adjust the control setting if necessary.

The H.T. voltage may be measured at top-row tags of the Power Supply Board. With the tags counted from the front panel towards the rear of the unit, a suitable voltmeter (e.g., AVO Model 8 set to the 10V d.c. range) should be connected between the 3rd tag (negative meter-terminal) and 4th tag (positive meter-terminal).

The H.T. supply should be 8·5V; if necessary the control setting should be adjusted for this value.

5.3 OSCILLATOR TRIMMER

The oscillator trimmer (reference C1 on diagram E32/99) is incorporated in the printed circuit stage TPC62/1: see Figure 1. The control is preset for an oscillator frequency of precisely 1Mc/s. The accuracy of the instrument is dependent upon this frequency, and in normal circumstances no alteration should be made to the setting of the trimmer.

The oscillator frequency may be monitored at the rear-mounted 'Std. Freq. O/P' socket when the Function Selector is set to Period 1μs. If at some time (e.g., after the instrument has given long service) frequency drift is found to have occurred, the trimmer should be adjusted for the necessary 1Mc/s oscillator frequency which may be checked by comparison with a suitable external standard frequency.

6. CIRCUIT DESCRIPTION

6.1 STAGE COMPLEMENT, DIAGRAMS & NOTATION

The main circuit of the instrument is illustrated by diagram ES66/16 which depicts eleven transistorized printed-circuit stages; for these, separate sub-circuit diagrams are provided.

The stages and their respective circuit diagram numbers are as follows.

Stage Type No.	Title	Diagram No.	Quantity
TPC34	Blanking Circuit	E66/9	1
TPC60	Double MF Decade (divider)	E32/77	2
TPC60/1	Double MF Decade (counter)	E32/84	2
TPC61	HF/MF Decade (divider)	E32/78	1
TPC61/1	HF/MF Decade (counter)	E32/98	1
TPC62/1	Crystal Oscillator Unit	E32/99	1
TPC67	Pulse Shaper & Gate Unit	E66/15	1
TPC20	Power Supply Board	E66/17	1
TPC17*	B.C.D. Buffer	E66/18	1

Certain component references (e.g., R1, C1 etc) occur on more than one diagram. To avoid ambiguity in the circuit description appearing in Sections 6.2 to 6.15 all component references pertaining to the main circuit diagram (ES66/16) are shown underlined (e.g., T1). Unless clearly indicated to the contrary, each reference of the transistorized printed circuit stages pertains to the circuit whose bracketed diagram number most closely precedes it in the text.

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*Fitted only for modification 'Z'

6.2 POWER SUPPLIES

Mains/Battery Input

On the main circuit diagram (ES66/16) switch SF(1 & 2) is the Mains/12V D.C. supply selector.

The mains input cable is represented by the lines marked Red (supply 'live'), Black (supply 'neutral'), and Green (earth).

Switch SA5 is the mains ON/OFF switch (ganged to the Function Selector) and capacitor C7 is an interference-suppressor. The mains supply is applied to the primary winding of transformer T1 via a pre-selected tap.

Socket SKT'G' is the battery input connector.

H.T. Supply

On mains operation the bridge-rectifier MR2 is fed by the 14V secondary winding of T1. The output of this full-wave rectifier passes via the fuse FS1 (0·5A) and is stabilized by a conventional series stabilizer circuit comprising transistor VT1, capacitor C8, and the circuit of the power supply board (E66/17). The positive output-line of MR2 links with chassis-earth via the switch SF2.

In the circuit of the power supply board the reverse breakdown voltage of a silicon Zener diode, MR1, is used as a reference potential for the emitter circuit of VT2. The collector current of this transistor controls the series stabilizers VT1 and VT1. The output, preset to 8·5V* by potentiometer RV1, effective in the base circuit of VT2, serves as H.T. supply for the instrument.

On battery operation MR2 is fed by the 12V d.c. input applied at socket SKT'G'. In the bridge-rectifier, the diode connecting the negative supply-line to C8 ensures that current is supplied to the H.T. stabilizer circuit only in the event of correct connection of the 12V d.c. input. The supply effectively replaces the rectified transformer-output obtained on mains operation.

Oven Supply

On mains operation the supply lines of the thermostatically controlled crystal oven (XX on main diagram) are fed by the output of transformer T1 via SF1 stator 2.

On battery operation the crystal oven is powered by the 12V d.c. input via SF1 stator 1.

Indicator Lamp Supply

On mains operation bridge-rectifier MR3 is fed by the secondary winding of T1. The output of the rectifier (approx. 12V) supplies the lamp circuit which is treated in a later section of this manual. The positive output-line is linked to chassis-earth by switch SF2.

On battery operation MR3 is fed by the 12V d.c. input: the diode connecting the negative supply-line to the negative output line protects the lamp circuit in the event of incorrect battery connection.

6.3 OSCILLATOR

The oscillator circuit (E32/99) is housed by the printed-circuit board TPC62/1 and incorporates transistor VT1 which operates in conjunction with the external oven-controlled crystal XL1. The oscillator is trimmed for an operating frequency of 1Mc/s by the preset capacitor C1.

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*Positive line to chassis-earth

When the Crystal Reference switch SC is set to 'INT', signals from the emitter load of VT1, available at TP23, are fed to TP25 and pass via an inverter, VT2, to a Schmitt trigger circuit comprising VT3 and VT4.

Note: With the switch set to 'EXT' the oscillator is isolated, and signals applied to the external crystal reference input socket SKT'H' pass via the inverter and Schmitt circuit.

Output signals of rectangular waveform (frequency 1Mc/s) are produced at the collector of VT4, which is linked to terminal point TP17.

6.4 FIRST FREQUENCY DIVIDER CHAIN

This frequency divider chain consists of five cascade-connected decade circuits, the first two of which are housed by TPC61.

The 1Mc/s signals from TP17 of the Schmitt trigger circuit (E32/99) feed the first or HF decade (E32/78) via its input point TP39. Basically the decade consists of four cascade-connected binary stages formed by transistors VT9-16; transistor VT17 serves as an output emitter-follower, VT19 as feedback-pulse shaper, and VT18 as output pulse shaper/inverter.

The decade operates as a divide-by-ten stage and produces one positive-going pulse at the output, TP1, for every ten positive-going signals received at its input, TP39. Signals of frequency 100kc/s are therefore produced at TP1; these signals are applied via C1 to the second decade which is formed by transistors VT1-8. The second or LF decade operates in a similar manner to that of the first unit: however, being a lower frequency decade no stages corresponding to VT17-19 are required; the output is therefore derived from the final binary circuit (VT8 collector) connected to TP3, where signals of frequency 10kc/s are produced.

These signals are supplied to the input point TP16 of the third decade (E32/99) which is housed by TPC62/1. The operation of this decade is similar to that of the second decade: output signals of frequency 1kc/s are therefore produced at output point TP5.

The 1kc/s signals are fed to the input point TP33 of the Double MF Decade Unit TPC60'a' (E32/77). This stage houses two cascade-connected decade circuits whose arrangements and operations are similar to those of the preceding decades. Signals of frequency 100c/s are produced at the cascading-junction TP6, whilst signals of frequency 10c/s occur at the final output point TP5.

6.5 SECOND FREQUENCY DIVIDER CHAIN

The second frequency divider chain consists of the two cascade-connected MF decades housed by TPC60'b' (E32/77). The operations of the decades are identical to those of the decades housed by TPC60'a'. In this case, however, the input point TP33 is fed with signals selected by the rotor of switch SA1 (a wafer of the Function Selector).

Signals at frequencies one-tenth and one-hundredth of the chain's input frequency are produced respectively at output points TP6 and TP5: the input frequency depends upon the function in which the instrument is set to operate: these functions are treated later in this manual.

6.6 INPUT CIRCUIT

The 'A.C./Test/D.C.' slide-switch SB(1-3) functions as circuit selector for Pulse Shaper and Gate Unit TPC67 (E66/15).

Within the unit, TP32 serves as input terminal point for emitter-follower VT1, which feeds a.c.-coupled amplifier/inverter VT2: the output of the latter stage is produced at TP25.

When switch SB(1-3) is set to 'A.C.', signals applied to the input terminals (TP1 & TP2) pass via the A.C. Sensitivity control RV13 and the circuit of VT1 and VT2. When the switch is set to 'Test', 100c/s signals from TPC60'a' (terminal point TP6) pass via this circuit (i.e., VT1 & VT2). For both switch-settings, signals produced at TP25 are fed to terminal point TP28.

For the 'D.C.' setting of the switch, signals applied to the input terminals pass via R3-C3 and are hence fed directly to TP28; the a.c.-input circuit of VT1 and VT2 is therefore not employed.

For all three switch-settings, signals presented to TP28 pass via the d.c.-coupled amplifier/inverter VT3, which feeds the Schmitt trigger circuit of VT5 and VT6.

Rectangular pulses at either the input or the test frequency are produced at the output of the Schmitt circuit, i.e., at TP19. These signals are selected by the rotor of Function Selector wafer SA2 on Frequency function, but by wafer SA1 on Period function.

6.7 GATING CIRCUIT

This circuit (E66/15), housed by TPC67, has two input lines, a START line connected to terminal point TP15 and a STOP line connected to TP14.

The gate control circuit comprises transistors VT7-10 which are arranged to function as two interlocked binaries. The first or START binary comprises VT7 and VT8; the second or STOP binary comprises VT9 and VT10.

Prior to gating action, a reset signal (applied to the junction of R23 and R30) sets the binaries to the condition in which the START binary is responsive only to a positive-going signal at the base of VT7, whilst the STOP binary is responsive only to a positive-going signal at the base of VT9.

With the binaries in this reset condition, the first positive-going 'start' signal supplied to TP15 passes via C11 and triggers the START binary. The collector potential of VT8 swings positive, and the STOP binary is triggered by the resultant positive pulse passed via C14 to the base of VT9. VT10 collector potential swings from approximately -8V to approximately -2V as the STOP binary is triggered.

In this new condition, the START binary is no longer responsive to signals via C11, and the STOP binary is responsive only to a positive-going signal via TP14. The next positive-going signal ('stop' signal) supplied to TP14 passes via C17 and triggers the STOP binary back to its original condition; the collector potential of VT10 consequently swings back to approximately -8V, having remained at the more positive potential (approx. -2V) for a duration equal to the gating time (i.e., the interval between the 'start' and 'stop' signals).

With the Gate Control switch SD(1 & 2) set to select external gate control, the input point TP15 is subject to 'start' signals supplied to socket SKT'A' whilst TP14 is subject to 'stop' signals supplied to SKT'B'. With the switch set to select internal gate control, terminal points TP14 and TP15 are linked together; single-line control is then employed, the 'start' and 'stop' signals being consecutive positive-going signals supplied from the rotor of Function Selector wafer SA4.

Within the stage TPC67 transistors VT11 and VT12 form a common-emitter gate. The collector potential of VT10 (available at terminal point TP10) feeds the base of VT11 and serves as the control input for the gate. Signals supplied to terminal point TP7 are applied to the base of VT12; corresponding signals are produced at the output of the gate (TP9) whenever the control input is at the more positive potential (VT10 collector approx. -2V).

Signals fed to the gate via TP7 are supplied by the Function Selector wafer SA2. Signals passed through the gate to TP9 are fed to the Counter Chain.

6.8 COUNTER CHAIN & INDICATORS

From TP9 of stage TPC67, gated signals are fed to the counter chain which comprises six cascade-connected decade circuits, each of which serves as a counter stage.

The first two decades of the chain are housed by TPC61/1. In the circuit of this stage (E32/98) transistors VT9-19 form the first or H.F. decade, which is fed via TP39, and VT1-8 form the second decade. The output of the first stage is coupled to the input of the second by capacitor C1. The respective decades operate in a similar manner to those of TPC61 (refer to Section 6.4); but in addition, 'staircase' current outputs representative of the respective count conditions of the stages are provided, at TP40 (1st decade) and TP1 (2nd decade).

The output of the second decade, produced at TP3, is fed to terminal point TP33 of stage TPC60/1'a' (E32/84). This is the first of two identical stages which are cascade-connected and respectively house the 3rd & 4th, and 5th & 6th decades of the chain. These decades operate in a similar manner to those of stage TPC60 (refer to Section 6.4) but 'staircase' current outputs are provided at TP32 and TP6.

Each of the six cascade-connected decades constituting the chain serves as a scale-of-ten counter and produces one positive-going output pulse for every ten pulses received at its input. Six indicators M1-6, individually driven by the 'staircase' outputs of the decades, display the count. Potentiometers RV1-12 are the Set Zero (odd numbered) and Set Nine (even numbered) controls provided for adjusting the displays of the indicators.

6.9 OPERATION FOR FREQUENCY FUNCTION

With switch SD(1 & 2) set for internal gate control, the circuit functions as follows.

The rotor of switch-wafer SA1 feeds the 10c/s signals from TP5 of stage TPC60'a' to the input of the second frequency divider TPC60'b'. As a result, signals of frequency 0·1c/s and 1c/s are available at stators 2 and 3, respectively, of wafer SA4; whilst 10c/s signals from TP5 of stage TPC60'a' are available at stator 4.

One of these frequencies (0·1, 1, 10c/s) is selected by the rotor of SA4 to control the gating circuit, via TP14 and TP15, of stage TPC67. Thus the gate is opened for 10 seconds (switch position 2), 1 second (position 3) or 0·1 second (position 4) according to the setting of the Function Selector SA.

Signals at the input frequency (applied at TP1) or at the 100c/s test frequency (obtained from TP6 of TPC60'a'), depending upon the setting of switch SB, are produced at TP19 of stage TPC67: refer to Section 6.6. The signals are fed via switch-wafer SA2 (any position 2-4) to the input of the gate: TP7 of stage TPC67. The signals are gated for the pre-selected time (set by SA4) and are hence passed to the counter chain via TP9 of the gating stage.

6.10 OPERATION FOR PERIOD FUNCTION

With switch SD(1 & 2) set for internal gate control, the circuit functions as follows.

Signals at the input frequency (or at the test frequency if SB is set to 'Test') are produced at TP19 of stage TPC67; they are hence fed via switch-wafer SA1 to the input of the second frequency divider TPC60'b'.

Signals at this frequency or at one-tenth or one-hundredth of this frequency (available at TP33, 6 and 5 respectively of the second divider) are selected in accordance with the setting of the Period Cycles slide-switch SKT(1-3) and are fed to switch-wafer SA4 stators 5-10: the signals are applied to TP14 & TP15 of stage TPC67 and serve to control the gate.

During the gating time (i.e., selected signal 'period') signals at one of six frequencies, produced by the first frequency divider and selected by switch-wafer SA2, pass via the gate (TPC67, TP7, & TP9) to the counter chain.

The SA2-stator/frequency relationship is as follows.

Stator 5	:	10c/s
Stator 6	:	100c/s
Stator 7	:	1kc/s
Stator 8	:	10kc/s
Stator 9	:	100kc/s
Stator 10	:	1Mc/s

6.11 STANDARD FREQUENCY OUTPUT

This output is selected, by the rotor of switch-wafer SA3, from eight signal frequencies obtained from the first and second frequency dividers. Signals at the selected frequency are fed to socket SKT'F'. The switch-setting/Std. Frequency output relationship is listed in Section 2.11.

6.12 DISPLAY TIMING & RESET ZERO CIRCUIT

This circuit (E66/15) incorporates VT13 and VT14, which form a monostable multivibrator, and VT15 & VT16 which operate as inverters. With the RESET switch SE(1 & 2) set to 'Auto', operation is as follows.

Diode MR4 (connected to VT7 collector) normally conducts to hold the multivibrator inoperative. As a 'start' signal is received and the collector potential of VT7 swings negative (refer to Section 6.7) diode MR4 becomes reverse-biased, and the operation of the multivibrator circuit is subject to signals, passed via R37, from the collector of VT10 (2nd transistor of STOP binary).

The collector potential of VT10 swings negative at the conclusion of the gating period. This signal is applied (via R37) to the base of VT13 so that the transistor is triggered to the conductive state; cut-off of VT14 collector current results.

The multivibrator remains in this condition for the pre-set display time (approx. 1-5 seconds) which is dependent upon the time-constant of the circuit formed by C20 and the series-parallel connected resistances R19, R4 and RV14.

As C20 discharges (so that the base potential of VT14 becomes negative with respect to the emitter), transistor VT14 conducts and the circuit reverts to the original or stable state (i.e., VT13 non-conductive; VT14 conductive). A positive-going signal is therefore produced at the collector of VT14, and a pulse is applied to inverters VT15 and VT16. The resultant negative-going signal produced at VT16 collector (and at TP1) constitutes a Reset Zero pulse.

When the multivibrator reverts to the stable state, the charge held by C19* ensures that the circuit cannot be triggered again for approximately 800ms which allows time for capacitor C20 to charge fully. Therefore, in the event of a very short gating period occurring immediately after reset action, the charge of C19 delays triggering of the multivibrator and so avoids a reduced display time which might otherwise occur if C20 were insufficiently charged.

With the RESET switch SE(1 & 2) set to 'Manual', the base of VT14 (linked to TP5) is connected via R18 to chassis-earth, and thus the multivibrator is held inoperative.

The collector of VT14 is connected via TP6 to the RESET IN socket SKTD.

A Reset input signal**, or momentary depression of the push-button SG, gives rise to a positive-going signal at the collector of VT14 and to a negative-going pulse at TP1 and at the collector of VT15.

The latter pulse is fed, via R23 and R30, to the gate-control binaries and resets them to the zero condition. The pulse produced at TP1 is applied to the main reset zero line (connected to terminal points of various stages as indicated on the main circuit diagram) so that the decades of the counter chain and both frequency divider chains are reset to the zero condition in readiness for a further measurement. The Reset Zero pulse is also fed to the RESET OUT socket SKTE.

6.13 RESET NINE CIRCUIT

Resistor R75 of stage TPC61/1, capacitor C6, and the normally closed push-button SH (which links the junction of R75 and C6 with the chassis-earth line) form the Reset Nine circuit. When the push-button is pressed, the potential of the reset-nine line swings negative from chassis-earth potential. The change in level is applied (via TP36 of TPC61/1, and TP1 of each TPC60/1 stage) to the six decades of the counter chain and sets them to the 9-condition; a display of '999999' is therefore presented by the indicators.

This facility is used in checking the indicator displays: refer to Section 4.3.

6.14 BLANKING CIRCUIT

The indicator lamp supply (approx. 12V d.c.) is provided between chassis-earth (+ve) and the Y connection (-ve) of rectifier MR3.

This supply feeds the parallel connected lamps either:

(i) Via the Blanking switch SJ when it is set to the OFF position (In this case the lamps are illuminated while the instrument is switched ON).

or (ii) Via Blanking Circuit (E66/9) transistors VT5 & VT6 when switch SJ is set to ON and the transistors are in the conductive state. (With this switch-setting the lamp current is cut off for the entire gating period).

The parallel-connected transistors VT5 and VT6 are controlled by the circuit incorporating VT1 & VT2 (arranged as a binary) and emitter-followers VT3 & VT4. This circuit is operated by the gate-control-potential (refer to Section 6.7) which is applied via TP2 to R1 and C1.

The gate-control-potential may be at either of two levels: approx. -8V (gate closed) or approx. -2V (gate open).

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*Time constant : approx. C19 x R37

**Refer to Section 2.8

While the control potential is at the more negative level (approx. -8V), collector current flows via VT1; as a result, VT2 is held non-conductive whilst VT3, MR3 and VT4 conduct to hold 'ON' transistors VT5 & VT6. Lamp current therefore flows to illuminate the display. When the control potential swings positive to approx. -2V, a positive-going pulse is applied, via C1 and MR2, to the base of VT1. This triggers the binary circuit to the reverse state. As VT2 conducts, current ceases to flow via the Zener diode MR3, and cut-off of collector current (lamp current) in VT5 and VT6 results.

The condition of blanking (non-illumination of the lamps) is maintained until, at the end of the gating period, the -8V level is restored to reverse the condition of the binary (VT1-VT2), and lamp current again flows via VT5 and VT6.

To allow time for the indicator movements to settle (as certain of these may be in the half full-scale deflection position if a high speed count has occurred, whilst others, e.g., the M.S.D. indicator, may be in motion), a delay of approximately 450ms in the reversal of the binary VT1-VT2 is introduced by the time-constant C4 x R1, effective in the base circuit of VT1.

6.15 B.C.D. OUTPUT CIRCUIT

This circuit, wired only when modification 'Z' is ordered, is represented in the right-hand region of diagram ES66/16. A collector of each binary circuit constituting the counter decades is connected either directly or (in the case of the high frequency decade) via resistors of B.C.D. Buffer stage TPC17 to output socket SKT'J'. The B.C.D. output is produced in the code 1-2-4-2'.

The gate-control-signal (refer to Section 6.7) is applied to TP3 of stage TPC17 (E66/18) and hence passes via VT1 and TP8 to SKTJ pin 33. A negative-going Print/Punch Command signal is produced at this output connection upon closure of the gate. The Reset IN line is connected to SKTJ pin 31 and facilitates the initiation of reset action by signals from external data logging equipment.

Signals produced at the B.C.D. output socket are specified in Section 2.10.

7. CIRCUIT REFERENCES

7.1 CIRCUIT ES66/16 (MAIN CIRCUIT) REFERENCE

		Venner Part Number
Resistors		
R1	47kΩ	X20635/23
R2, (20-24)	Not used	-
R3	10kΩ	X20635/16
R4	820kΩ	X20635/41
R5, 7, 9, 11, 13, 15	4·7kΩ	X20635/12
R6, 8, 10, 12, 14	6·8kΩ	X20635/14
R16	2·2kΩ	X20635/9
R17, 18	3·3kΩ	X20635/10
R19	18kΩ	X20635/18
R25	1kΩ	X20635/6
Resistors Variable		
RV1, 3, 5, 7, 9, 11	1kΩ (Set Zero controls)	X20999/38
RV2	20kΩ (Set Nine control)	X20999/40
RV4, 6, 8, 10, 12.	10kΩ (Set Nine controls)	X20999/39
RV13	500kΩ (A.C. Sensitivity control)	X20999/37
RV14	500kΩ (Display Time control)	X20999/37
Capacitors		
C1, 11	Not used	-
C2	60pF	Y20641/9
C3	120pF	Y20641/4
C4	0·22μF	Y23914/9
C5	220pF	Y20641/5
C6	4μF	Y20643/3
C7 (a-c)	0·1+0·005+0·005μF (mains supressor)	Z26102
C8	1125μF	Y20643/16
C9	0·04μF	Y20642/3
C10	8μF	Y20643/4
C12	200μF	Y20643/22
Rectifiers		
MR1	Not used	-
MR2, 3	M200	Z20648/9
Transistor		
VT1	OC25	X20638/40
Fuse		
FS1	0·5A (H.T. fuse; 3/16"D x 5/8" cartridge)	Z19831
Meter Indicators		
M (1-5)	250μA F.S.D. E.A.C. MkII Digivisors	X27086
M6	166μA F.S.D. E.A.C. MkII Digivisor	X27088
Transformer		
T1	Albion type W0276 Pri: 0-102-112-122-205-225-245V Sec: 14V, 1·8A	Y50054
Crystal		
XL1	Marconi type QO 1670L (1Mc/s)	Y20650/5
Crystal Oven		
Oven	Cathodeon type MCO-2M with mounting socket	Z24489
Terminal/sockets		
TP1	Signal Input (high)	Z26797/1
TP2	Signal Input (earthy)	Z26796/1
Sockets		
SKT A	External Gating START Input	X20637/89
SKT B	External Gating STOP Input	X20637/89
SKT C	Earth	X20637/90
SKT D	External Reset IN	X20637/88
SKT E	Reset OUT	X20637/88

		Venner Part Number
Sockets		
SKT F	Standard Frequency Output	X20637/91
SKT G	Battery Input Connector (McMurdo type TRS1)	X20637/93
SKT H	External Crystal Reference Input	X20637/91
SKT J	B.C.D. Output	X20637/80
Switches		
SA (1-5)	Function Selector Position 1 : Mains supply OFF Position 2 : Frequency c/s X0·1 Position 3 : Frequency c/s X1 Position 4 : Frequency c/s X10 Position 5 : Period ms X100 Position 6 : Period ms X10 Position 7 : Period ms X1 Position 8 : Period μs X100 Position 9 : Period μs X10 Position 10 : Period μs X1	Y50022
SB (1-3)	D.C./Test/A.C. Selector Position 1 : D.C. Position 2 : Test Position 3 : A.C.	Z50187
SC1	Crystal Reference Selector Position 1 : Internal Position 2 : External	Z27067
SD (1 & 2)	Internal/External Gating Selector Position 1 : Internal Position 2 : External	Z27067
SE (1 & 2)	Manual/Auto Resetting Selector Position 1 : Auto Position 2 : Manual	Z50166
SF (1 & 2)	Battery/Mains Supply-selector Position 1 : Battery Position 2 : Mains	Z27067
SG	Reset 0 Push-button	Z26855
SH	Reset 9 Push-button	Z26856
SJ	Blanking ON/OFF switch	Z50166
SK (1-3)	Period Cycles Selector Position 1 : X1 Position 2 : X10 Position 3 : X100	Z50187

7.2 CIRCUIT E32/77 (TPC60) REFERENCE

		Venner Part Number
Resistors		
R1,4,6,10,13,15,18,21,23,26, 29,31,35,38,40,43,46,48,51, 54,56,59,62,64	10kΩ	X20635/16
R2,11,19,27,36,44,52,60	Not used	-
R3,8,12,17,20,25,28,33,37, 42,45,50,53,58,61,66	2·2kΩ	X20635/9
R5,7,30,32,39,41,63,65	8·2kΩ	X20635/15
R9,34	27kΩ	X20635/20
R14,16,22,24,47,49,55,57	6·8kΩ	X20635/14
R67	68Ω	X20635/48
Capacitors		
C1,4,7,8,10,14,17,20,21,23	220pF	Y20641/5
C2,3,5,6,11,15,16,18,19,24	300pF	Y20641/7
C9,13,22,26	390pF	Y20641/8
C12,25	1000pF	Y20641/6
Diodes		
MR (1-20)	OA91	X20639/12
Transistors		
VT (1-16)	OC45	X20635/5

7.3 CIRCUIT E32/78 (TPC61) REFERENCE

		Venner Part Number
Resistors		
R1,4,6,10,13,15,18,21,23,26, 29,31,47,50,56,59,65,68	10kΩ	X20635/16
R2,11,19,27,42	Not used	-
R3,8,12,17,20,25,28,33,46,51 55,60,64,69,70,72	2·2kΩ	X20635/9
R5,7,30,32	8·2kΩ	X20635/15
R9	27kΩ	X20635/20
R14,16,22,24	6·8kΩ	X20635/14
R34	150Ω	X20635/46
R35	160kΩ	X20636/72
R36,42,75	1·5kΩ	X20635/7
R37,38,40,41	15kΩ	X20635/17
R39	240Ω	X20636/63
R43,61	72kΩ	X20636/29
R44,45,53,54,62,63	5·6kΩ	X20635/13
R48,49,57,58,66,67	7·5kΩ	X20636/9
R52	36kΩ	X20636/28
R71	1kΩ	X20635/6
R73,74	3·3kΩ	X20635/10
Capacitors		
C1,4,7,8,10	220pF	Y20641/5
C2,3,5,6,11	300pF	Y20641/7
C9,13	390pF	Y20641/8
C12	1000pF	Y20641/6
C(14-17),19,20,24,25,29,30	120pF	Y20641/4
C18	0·04μF	Y20642/3
C21,22,26,27,31,32	150pF	Y20641/12
C23,28	100pF	Y20641/11
C33	270pF	Y20641/19
Diodes		
MR (1-28)	OA91	X20639/12
Transistors		
VT (1-8),18	OC45	X20638/5
VT (9-17),19	OC44	X20638/17

7.4 CIRCUIT E32/84 (TPC60/1) REFERENCE

Resistors		Venner Part Number
R1, 4, 6, 10, 13, 15, 18, 21, 23, 26, 29, 31, 35, 38, 40, 43, 46, 48, 51, 54, 56, 59, 62, 64	10kΩ	X20635/16
R2, 36	72kΩ	X20636/29
R3, 8, 12, 17, 20, 25, 28, 33, 37, 42, 45, 50, 53, 58, 61, 66	2·2kΩ	X20635/9
R5, 7, 30, 32, 39, 41, 63, 65	8·2kΩ	X20635/15
R9, 34	27kΩ	X20635/20
R11, 44	36kΩ	X20636/28
R14, 16, 22, 24, 47, 49, 55, 57	6·8kΩ	X20635/14
R19, 52	17·6kΩ	X20636/48
R27, 60	34·75kΩ	X20636/49
R67	68Ω	X20635/48
Capacitors		
C1, 4, 7, 8, 10, 14, 17, 20, 21, 23	220pF	Y20641/5
C2, 3, 5, 6, 11, 15, 16, 18, 19, 24	300pF	Y20641/7
C9, 13, 22, 26	390pF	Y20641/8
C12, 25	1000pF	Y20641/6
Diodes		
MR (1-20)	OA91	X20639/12
Transistors		
VT (1-16)	OC45	X20638/5

7.5 CIRCUIT E32/98 (TPC61/1) REFERENCE

		Venner Part Number
Resistors		
R1,4,6,10,13,15,18,21,23,26, 29,31,47,50,56,59,65,68	10kΩ	X20635/16
R2,43,61	72kΩ	X20636/29
R3,8,12,17,20,25,28,33,46,51, 55,60,64,69,70,72	2·2kΩ	X20635/9
R5,7,30,32	8·2kΩ	X20635/15
R9	27kΩ	X20635/20
R11,52	36kΩ	X20636/28
R14,16,22,24	6·8kΩ	X20635/14
R19	17·6kΩ	X20636/48
R27	34·75kΩ	X20636/49
R34	150Ω	X20635/46
R35	160kΩ	X20636/72
R36,42,75	1·5kΩ	X20635/7
R37,38,40,41	15kΩ	X20635/17
R39	240Ω	X20636/63
R44,45,53,54,62,63	5·6kΩ	X20635/13
R48,49,57,58,66,67	7·5kΩ	X20636/9
R71	1kΩ	X20635/6
R73,74	3·3kΩ	X20635/10
Capacitors		
C1,4,7,8,10	220pF	Y20641/5
C2,3,5,6,11	300pF	Y20641/7
C9,13	390pF	Y20641/8
C12	1000pF	Y20641/6
C14,15,16,17,19,20,24,25,29,30	120pF	Y20641/4
C18	0·04μF	Y20642/3
C21,22,26,27,31,32	150pF	Y20641/12
C23,28	100pF	Y20641/11
C33	270pF	Y20641/19
Diodes		
MR (1-28)	OA91	X20639/12
Transistors		
VT (1-8),18	OC45	X20638/5
VT (9-17),19	OC44	X20638/17

7.6 CIRCUIT E32/99 (TPC62/1) REFERENCE

		Venner Part Number
Resistors		
R1, 2	68kΩ	X20635/25
R3	220Ω	X20635/1
R4, 5	3·3kΩ	X20635/10
R6	1kΩ	X20635/6
R7, 8, 10, 12	5·6kΩ	X20635/13
R9	470Ω	X20635/3
R11	100Ω	X20635/44
R13	270Ω	X20635/2
R14	Not used	-
R15	1·8kΩ	X20635/8
R16, 18, 20, 23, 25, 27, 30, 32, 34, 37, 39, 41	10kΩ	X20635/16
R17, 22, 24, 29, 31, 36, 38, 43	2·2kΩ	X20635/9
R19, 21, 40, 42	8·2kΩ	X20635/15
R26, 28, 33, 35	6·8kΩ	X20635/14
R44	27kΩ	X20635/20
R45	150Ω	X20635/46
Capacitors		
C1	4-60pF (trimmer)	Z21135/2
C2, 8, 11, 14, 15, 17	220pF	Y20641/5
C3	150pF	Y20641/12
C(4-7), 18	1000pF	Y20641/6
C9, 10, 12, 13, 20	300pF	Y20641/7
C16, 19	390pF	Y20641/8
Diodes		
MR (1-10)	OA91	X20639/12
Transistors		
VT (1-4)	OC44	X20635/17
VT (5-12)	OC45	X20635/5

7.7 CIRCUIT E66/15 (TPC67) REFERENCE

		Venner Part Number
Resistors		
R1	68kΩ	X20652/2
R2, 4, 12, 13, 14, 34, 36, 49, 52	Not used	-
R3	220kΩ	X20635/30
R5, 45	2·2kΩ	X20635/9
R6	39kΩ	X20635/22
R7	150kΩ	X20635/29
R8, 43	1kΩ	X20635/6
R9, 22, 24, 29, 31, 32	15kΩ	X20636/15
R10, 19	270Ω	X20635/2
R11	1kΩ	X20636/66
R15, 54	470Ω	X20635/3
R16, 18	5·6kΩ	X20636/79
R17	68Ω	X20635/48
R20	10kΩ	X20635/16
R21, 26, 28, 33, 35	1·5kΩ	X20636/8
R23, 30	12kΩ	X20636/93
R25	10kΩ	X20636/82
R27	270Ω	X20636/33
R37, 41	100kΩ	X20635/27
R38, 40	4·7kΩ	X20635/12
R39, 46	3·3kΩ	X20636/13
R42	8·2kΩ	X20635/15
R44	1·8kΩ	X20635/8
R47	82kΩ	X20636/84
R48, 50	100Ω	X20636/85
R51, 53	5·6kΩ	X20635/13
Capacitors		
C1	60pF	Y20641/25
C2, 8	Not used	-
C3, 20	30μF	Y20643/24
C4, 18	390pF	Y20641/8
C5, 7, 19	8μF	Y20643/4
C6	100μF	Y20643/15
C9	1000pF	Y20641/6
C10, 11, 17	150pF	Y20641/12
C(12-16)	120pF	Y20641/4
C21	4μF	Y20643/3
C22, 25	0·04μF	Y20642/3
C23	0·01μF	Y20642/7
C24	0·005μF	Y20642/1
Diodes		
MR1, 2, 3, 5, 6, 7	OA91	X20639/12
MR4, 8	OA202	X20639/18
Transistors		
VT1, 15, 16	OC42	X20638/53
VT2, 3, (5-12)	OC44	X20638/17
VT4	Not used	-
VT13, 14	OC45	X20638/5

7.8 CIRCUIT E66/9 (TPC34) REFERENCE

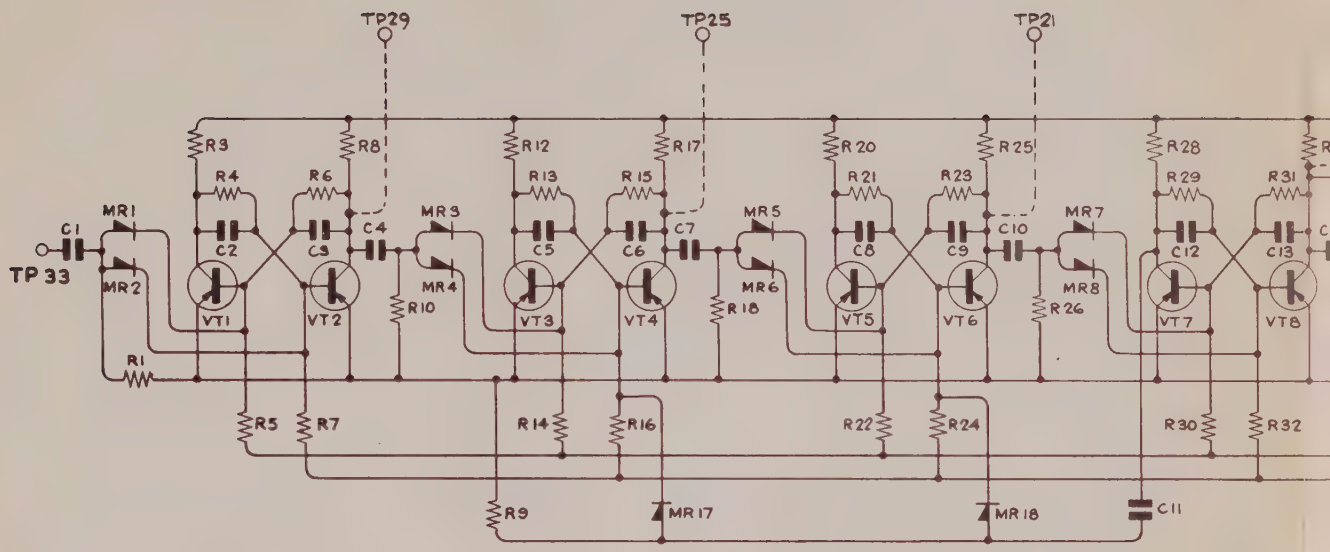
		Venner Part Number
Resistors		
R1,9,11	33kΩ	X20635/21
R2,3,12	4·7kΩ	X20635/12
R4	220Ω	X20635/1
R5	10kΩ	X20635/16
R6,7	22kΩ	X20635/19
R8	27kΩ	X20635/20
R10	820Ω	X20635/5
R13	2·2kΩ	X20635/9
R14,17	47Ω	X20635/34
R15,16	150Ω	X20635/46
Capacitors		
C1	220pF	Y20641/5
C2,3	560pF	Y20641/1
C4	16μF	Y20643/25
C5	30μF	Y20643/24
Diodes		
MR1	OA202	X20639/18
MR2	OA91	X20639/12
MR3	Z2A33F	X20639/8
Transistors		
VT1,2,3	OC45	X20638/5
VT4	BCZ11	X20638/34
VT5,6	OC83	X20638/51

7.9 CIRCUIT E66/17 (TPC20) REFERENCE

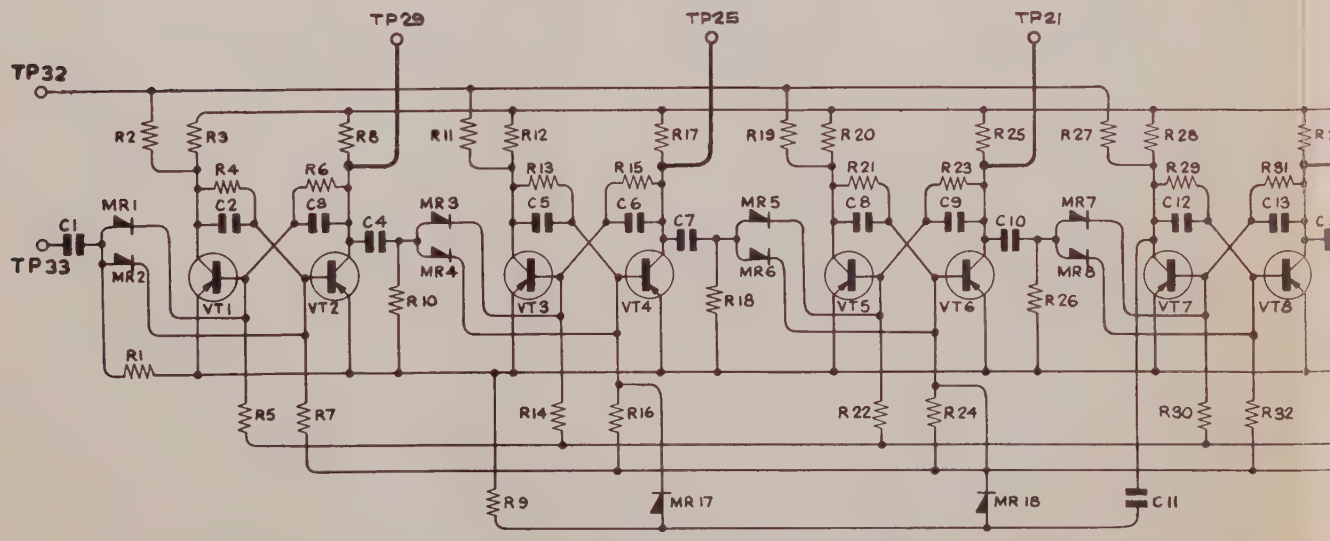
		Venner Part Number
Resistors		
R1	1·5kΩ	X20635/7
R2	2·2kΩ	X20635/9
R(3-5)	1kΩ	X20635/6
R6	4·7kΩ	X20635/12
R7	680Ω	X20635/4
Resistor Variable		
RV1	5kΩ	Y20640/1
Capacitors		
C1	16μF	Y20643/25
C2,3	30μF	Y20643/24
Diode		
MR1	SX56	X20639/5
Transistors		
VT1,2	OC71	X20638/1

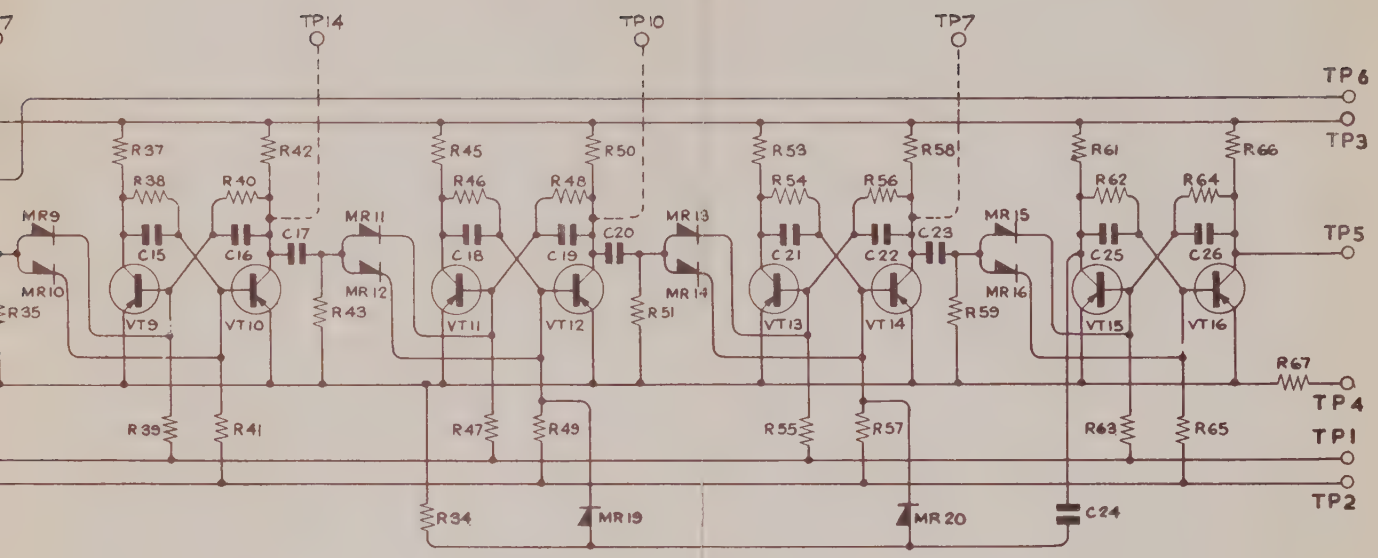
7.10 CIRCUIT E66/18 (TPC17) REFERENCE

		Venner Part Number
Resistors		
R1	330Ω	X20635/42
R2	1kΩ	X20635/6
R (3-6)	4·7kΩ	X20635/12
Transistor		
VT1	OC44	X20638/17

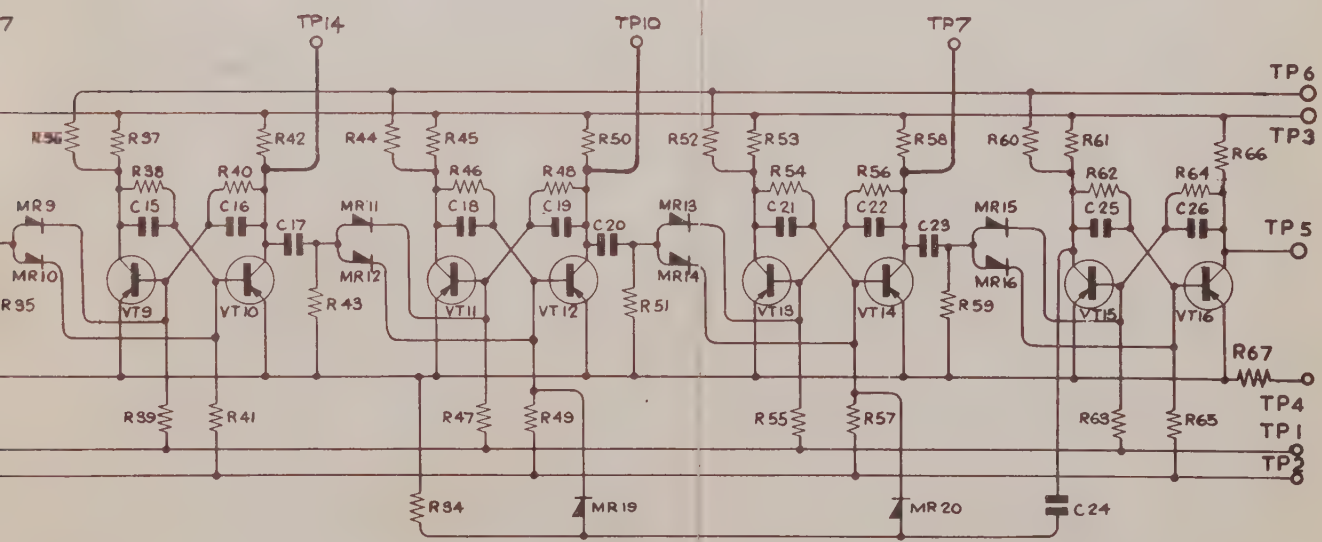


NOTE: CONNECTIONS SHOWN DOTTED ARE FOR BCD O/P WHEN REQUIRED

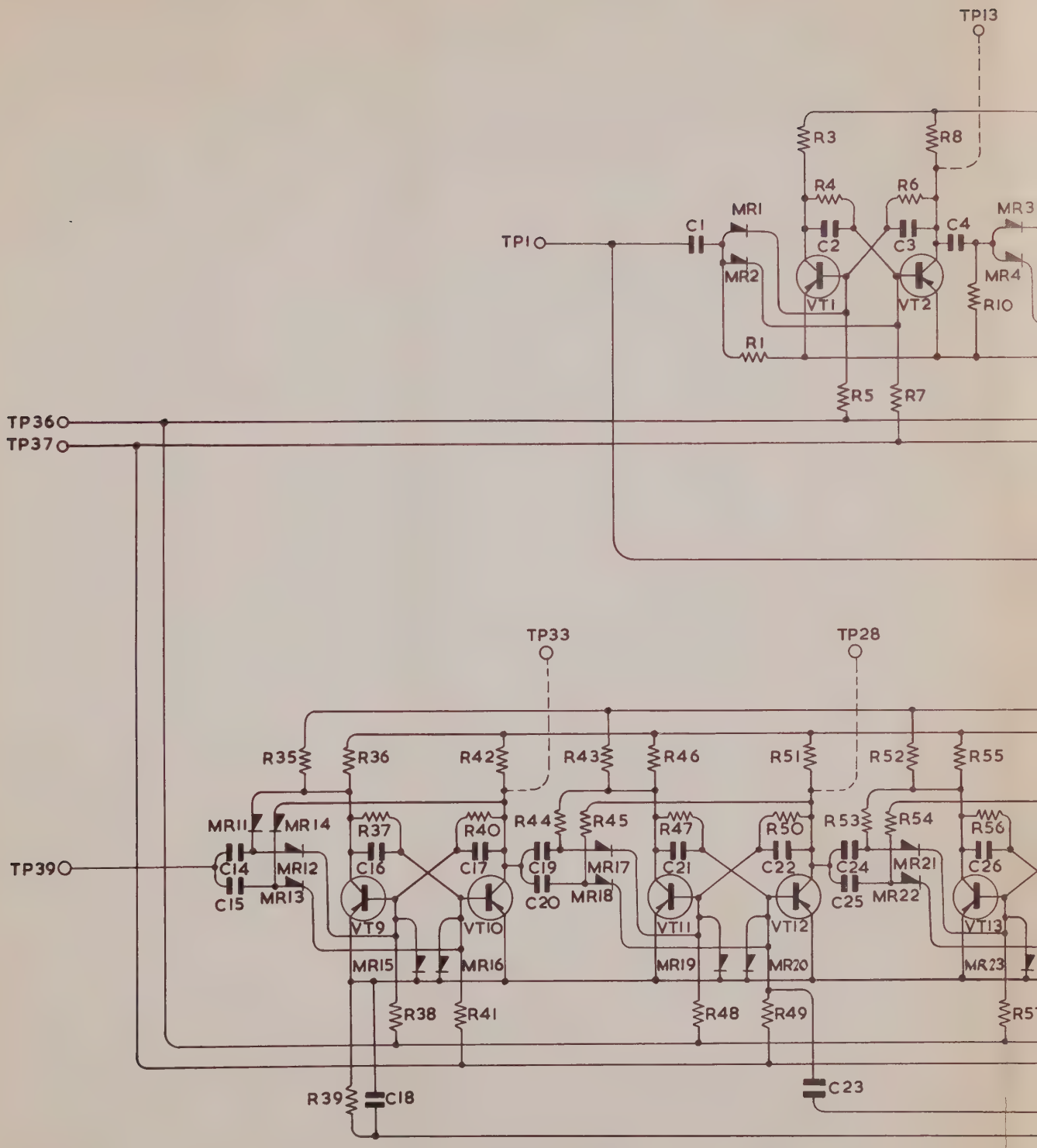




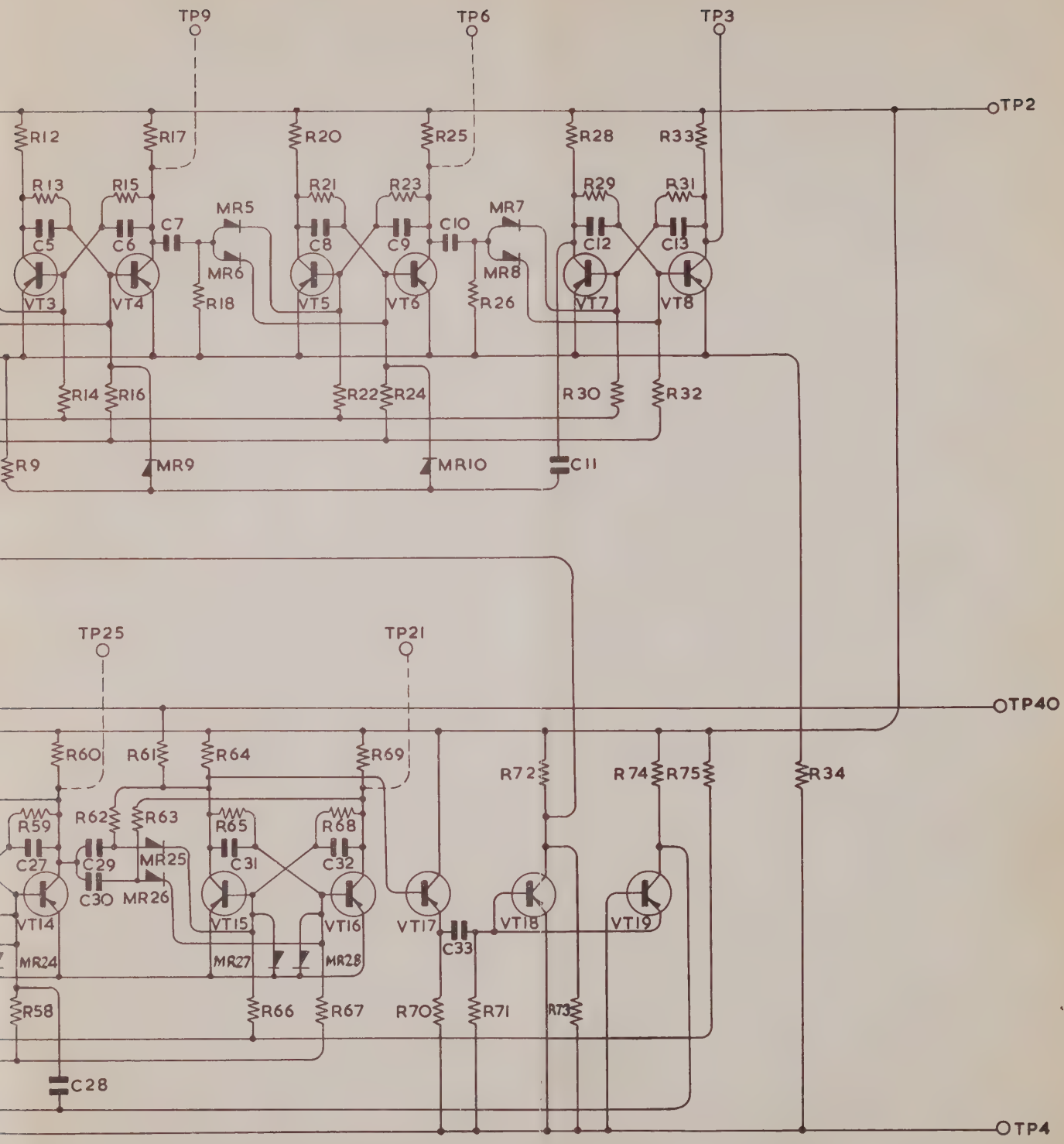
E32/77
DOUBLE MF DECADE
UNIT TYPE TPC 60



E32/84
DOUBLE MF DECADE
UNIT TYPE TPC 60/1

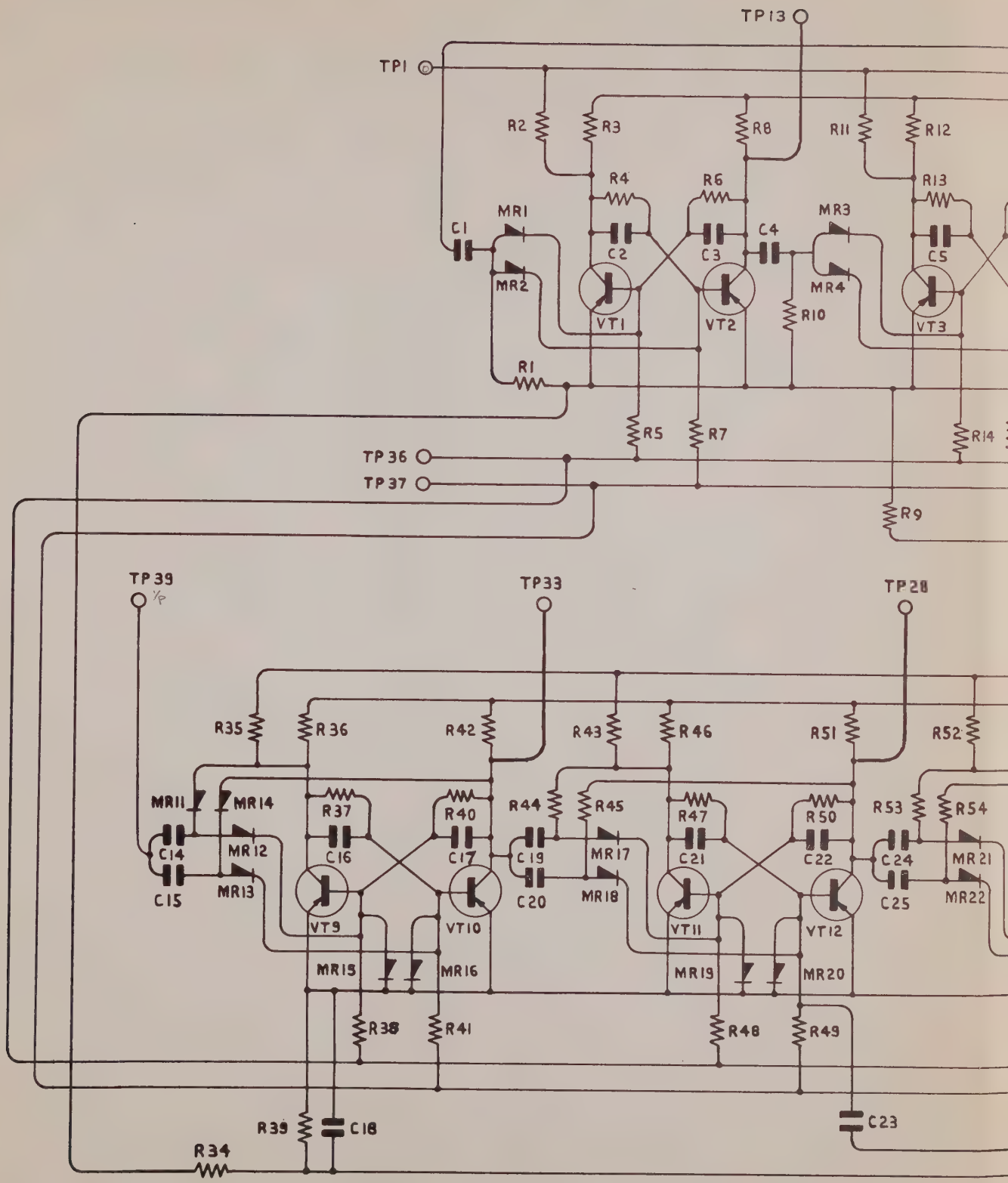


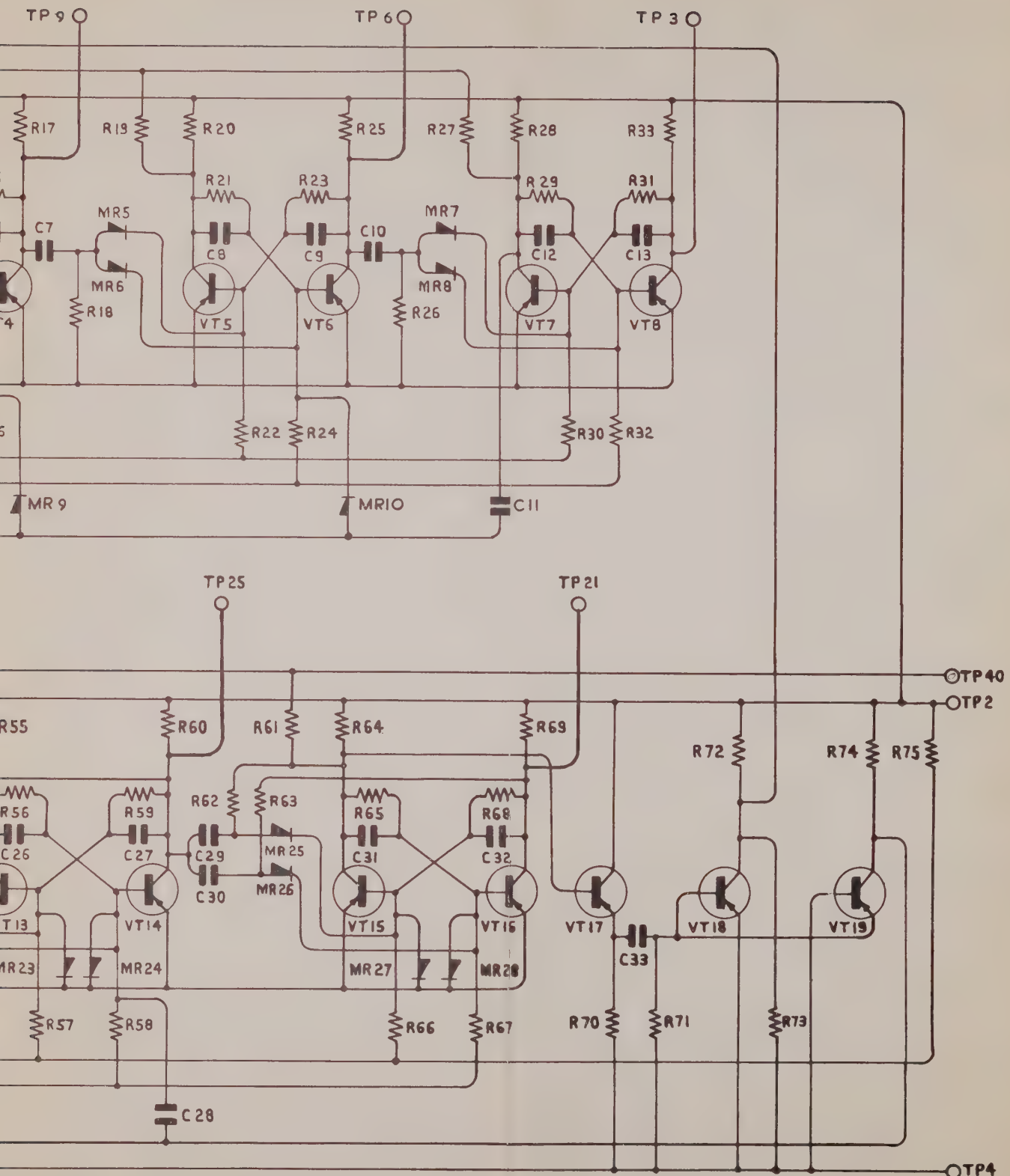
NOTE: CONNECTIO
BCD O/P



S SHOWN DOTTED ARE FOR
HEN REQUIRED.

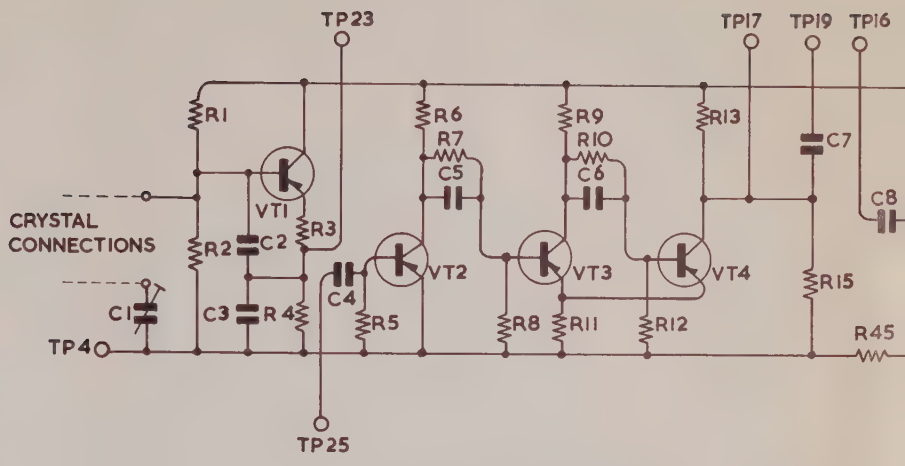
E32/78
HF/MF DECADE UNIT (DIVIDER)
TYPE TPC 61


TP13
TP1
R2
R3
R8
R11
R12
R4
R6
R13
MR1
C1
C2
C3
C4
MR3
C5
MR2
VT1
VT2
MR4
R10
VT3
R1
R5
R7
R14
TP36
TP37
R9
TP39
TP33
TP28
R35
R36
R42
R43
R46
R51
R52
MR11
MR14
R37
R40
R44
R45
R47
R50
R53
R54
C14
MR12
C16
C17
C19
MR17
C21
C22
C24
MR21
C15
MR13
C20
MR18
MR22
C25
VT9
VT10
VT11
VT12
MR15
MR16
MR19
MR20
R38
R41
R48
R49
R39
C18
C23
R34

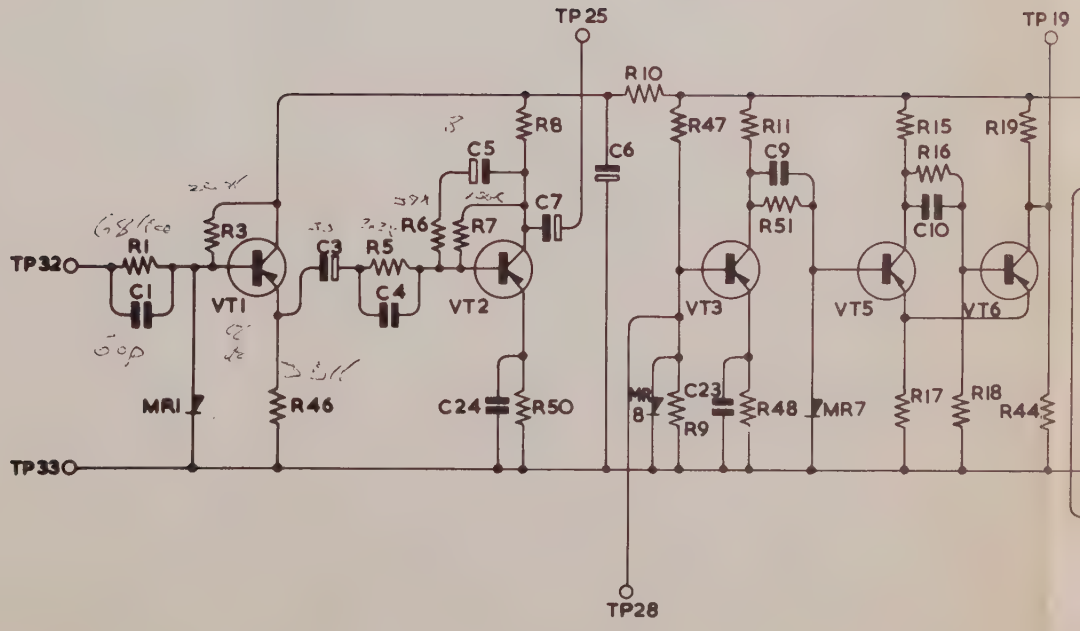


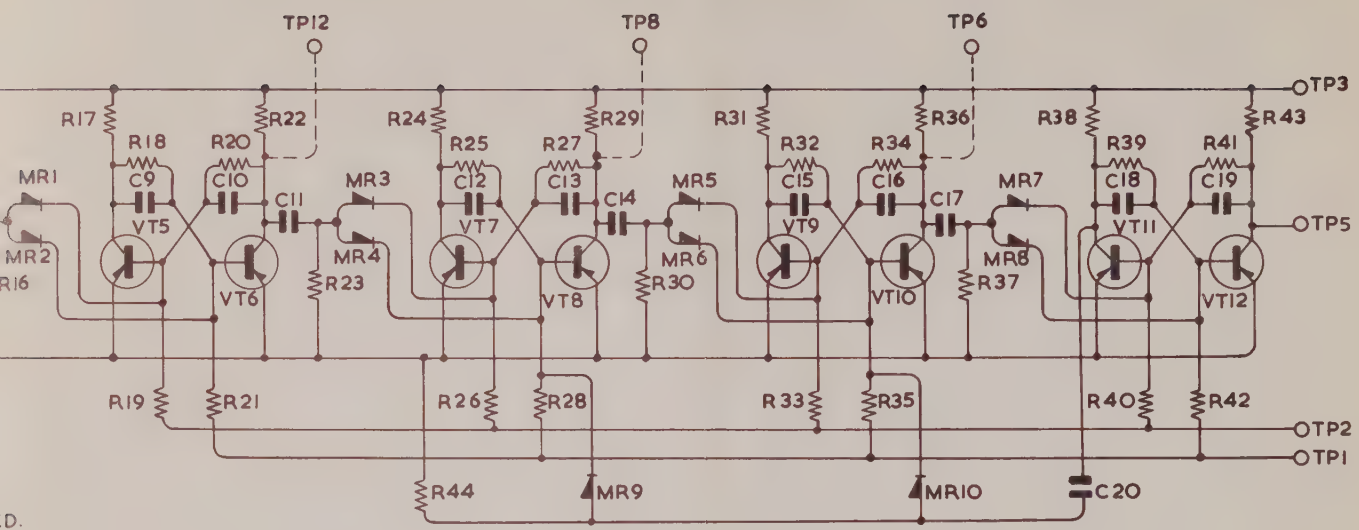
E 32/98

HF/MF DECADE UNIT
(COUNTER) TYPE TPC 61/1

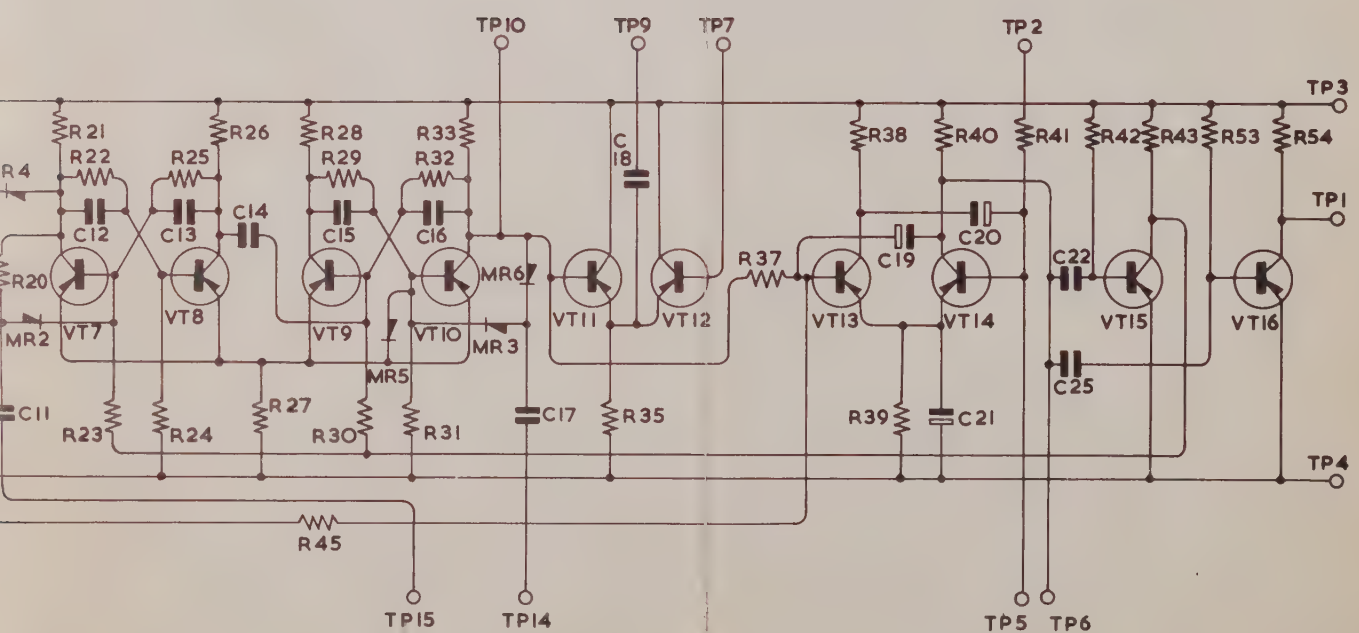


NOTE:-CONNECTIONS SHOWN DOTTED
ARE FOR BCD O/P WHEN REQUI

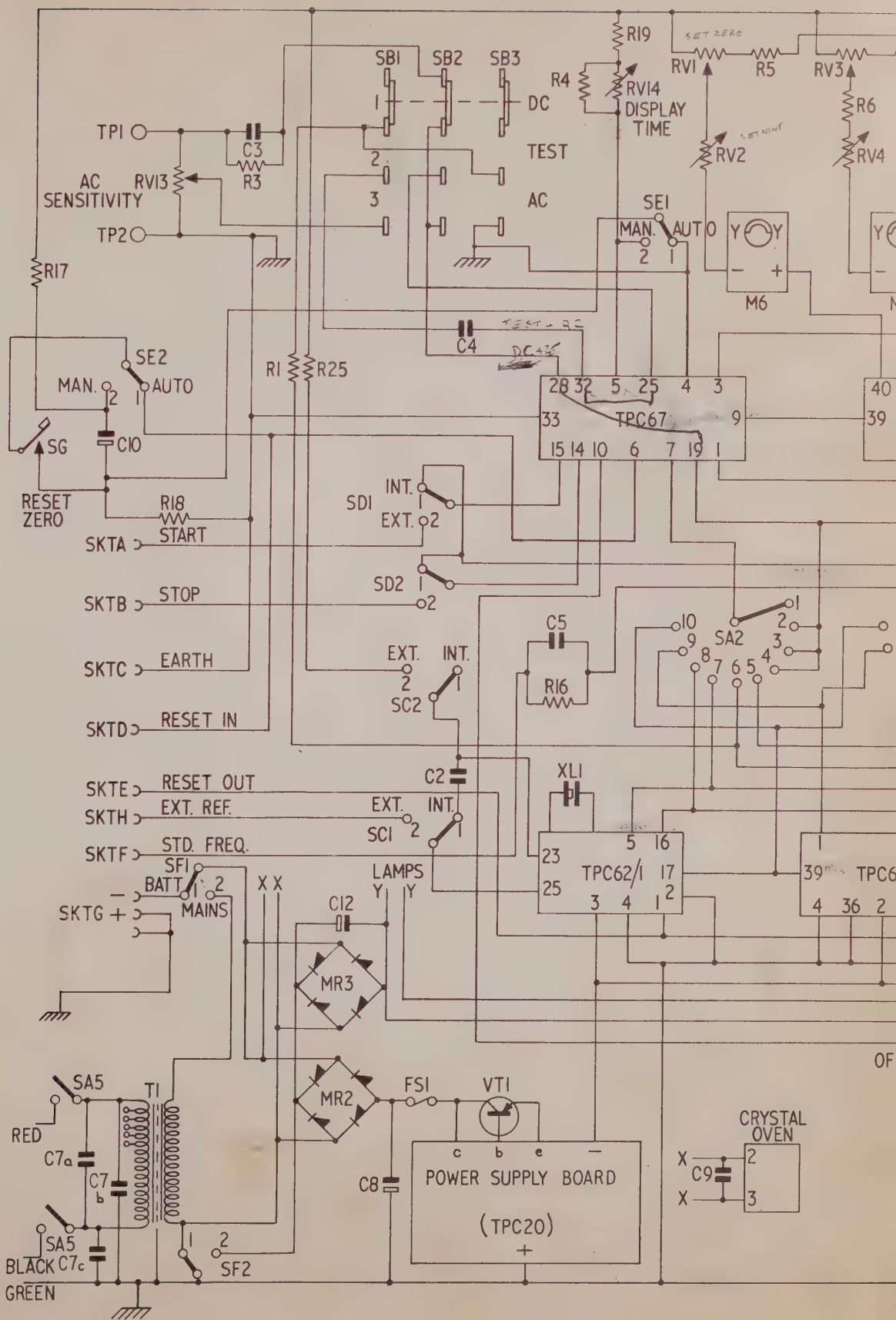


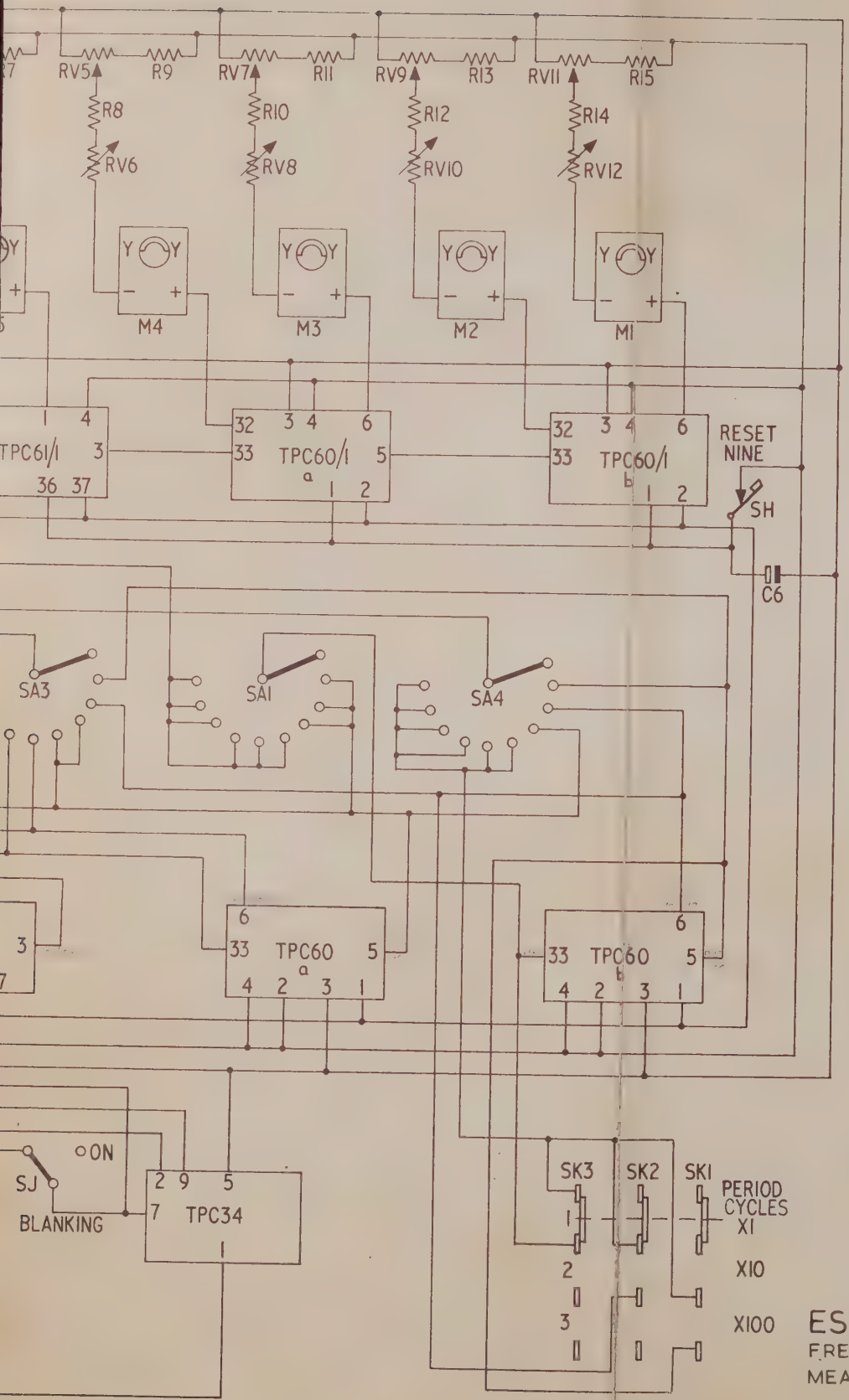


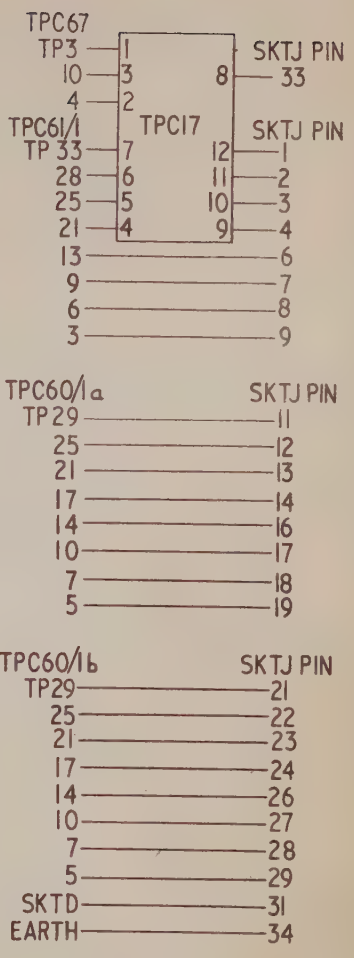
E 32/99
CRYSTAL OSCILLATOR UNIT
TYPE TPC 62/1



E 66/15
PULSE SHAPER & GATE UNIT
TYPE TPC 67

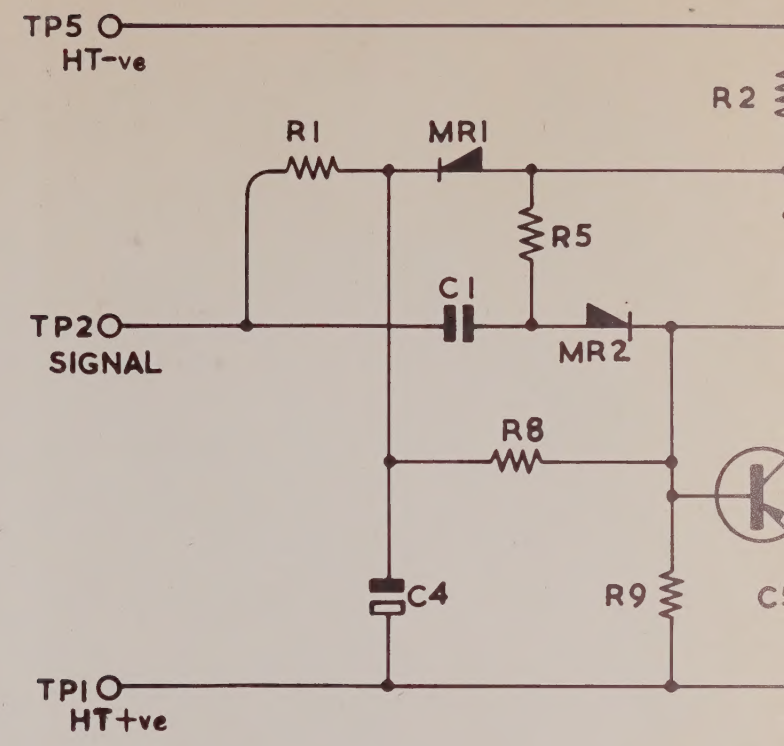

SB1
SB2
SB3
DC
TEST
AC
R4
RV14
DISPLAY TIME
RV1
R5
RV3
R6
RV2
RV4
SET ZERO
SET NINE
TP1
C3
R3
AC SENSITIVITY
RV13
TP2
RI7
SE1
MAN.
AUTO
M6
C4
TEST - DC
DC + AC
SE2
RI
R25
SG
C10
RESET ZERO
RI8
TPC67
SDI
INT.
EXT.
SKTA
START
SD2
SKTB
STOP
C5
RI6
SA2
SKTC
EARTH
SC2
SKTD
RESET IN
C2
XL1
SKTE
RESET OUT
SKTH
EXT. REF.
SC1
SKTF
STD. FREQ.
SF1
BATT.
MAINS
SKTG
LAMPS
C12
MR3
TPC62/1
MR2
FS1
VT1
SA5
T1
RED
C7a
C7b
BLACK
C7c
GREEN
SF2
C8
POWER SUPPLY BOARD
(TPC20)
CRYSTAL OVEN
C9

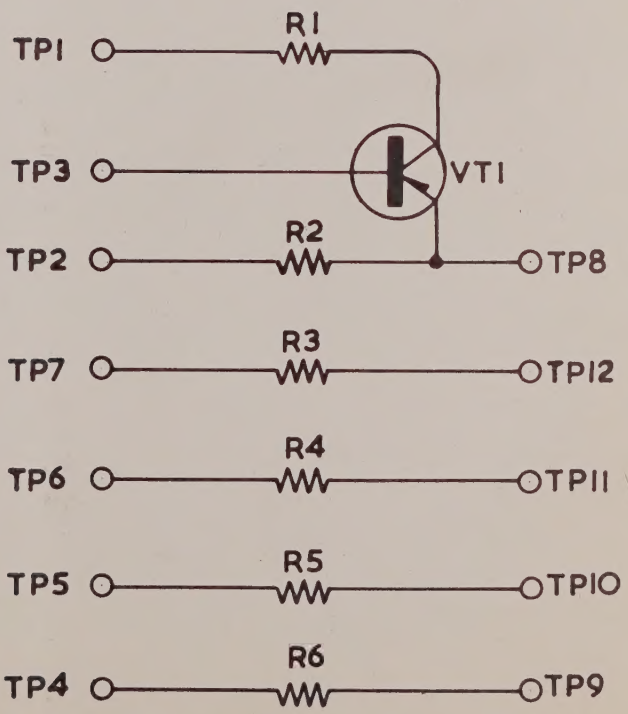




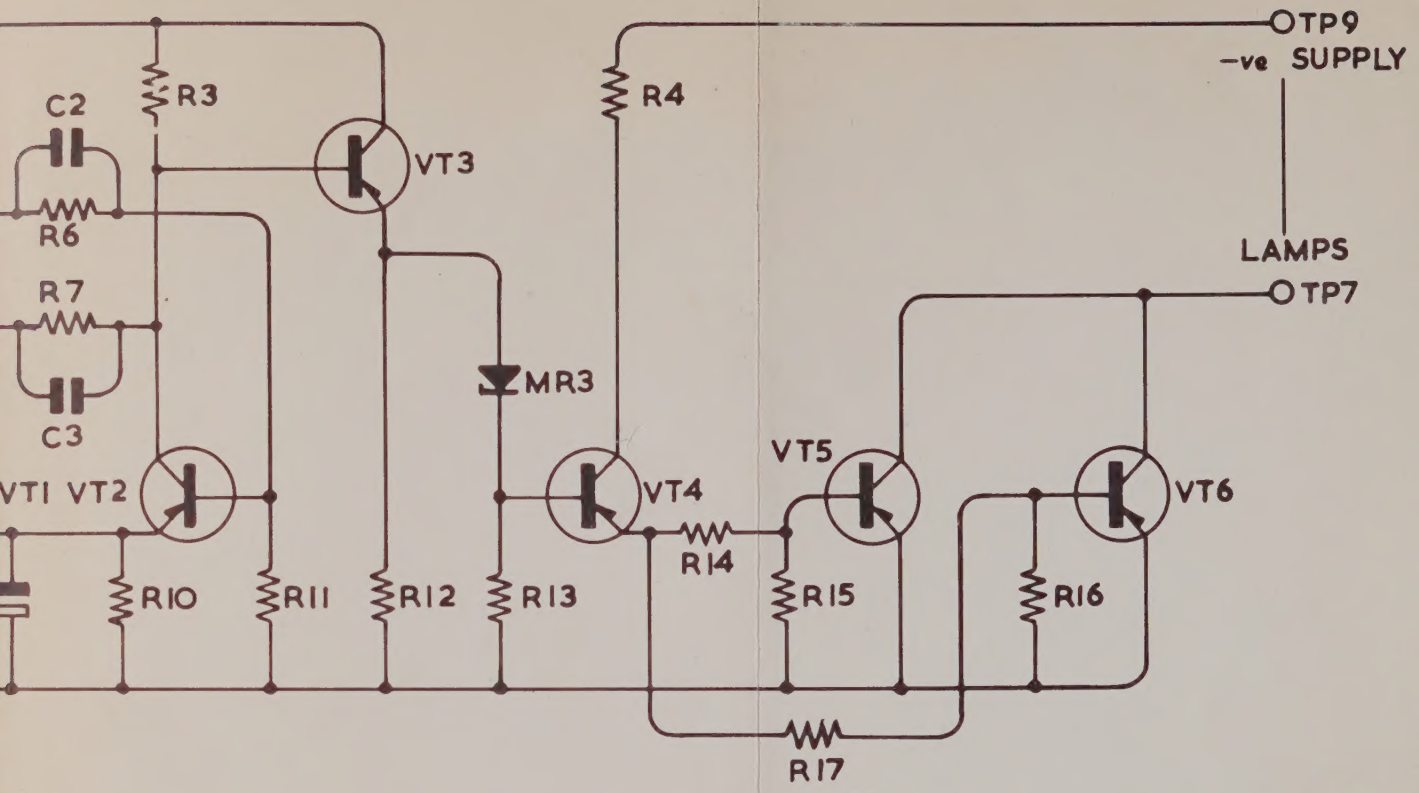
CIRCUIT ABOVE WIRED ONLY FOR MODIFICATION Z

ES66/16 (ISSUE C)
FREQUENCY AND TIME MEASURING EQUIPMENT TSA3436/2

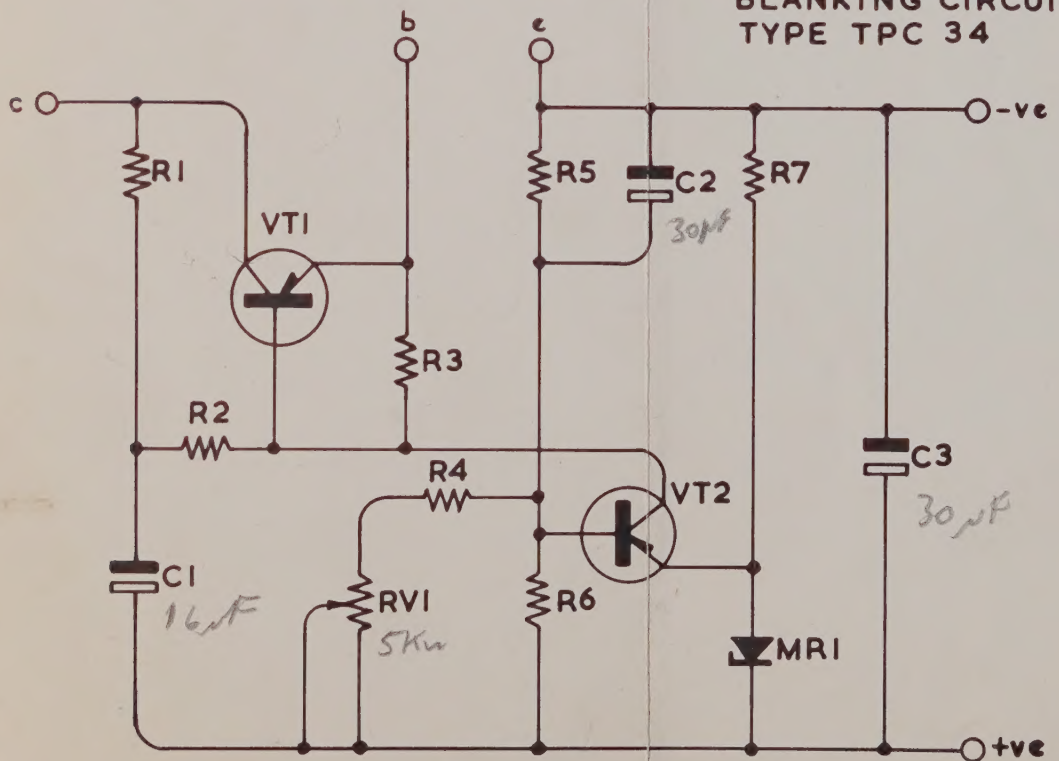




E66/18 B.C.D. BUFFER TPC 17



E66/9
BLANKING CIRCUIT UNIT
TYPE TPC 34



E66/17
POWER SUPPLY UNIT
TYPE TPC 20

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